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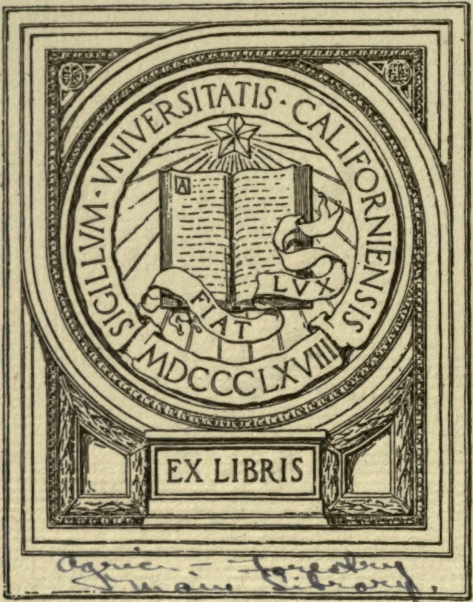

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CIRCULAR No. 121

OCTOBER, 1914

SOME THINGS THE PROSPECTIVE SETTLER SHOULD KNOW

BY

THOMAS FORSYTH HUNT
AND OTHER MEMBERS OF THE STAFF

> [A good many people are being detached from their customary employment or source of income by the pressure of the crisis in Europe. To all such who are looking about for a new start, the best suggestion we can give is that the land is the place where living is cheapest and the cost of shelter hardly exists at all. No man forced out of employment this winter is in worse plight than millions of immigrants who have landed in America with less than $50 in their pockets. Those immigrants who have gone to the land have been able in the course of a few years to acquire a farm, to raise families, and to participate in the most wholesome gifts that American civilization has to offer. To be forced from the city back to the farm may seem a hardship to the man who goes through the transition, but in the end he will be better off and his children will be benefited.—*Collier's.*]

An agent who is seeking to sell land, holds that he may, with propriety, state the maximum yield which may be expected from a given crop on the land which he is offering for sale. It is difficult to deny that he has such right. It is worth while, therefore, to consider whether there is any relationship between maximum yields and yields that may be expected in the ordinary run of business. The average yield of wheat in California, one season with another, is about 13 bushels. It varies in different seasons from 9 to 18 bushels per acre. On land that is fairly adapted to wheat good farmers not infrequently get 40 bushels per acre and no farmer thinks that his crop is to be commended unless he has obtained 25 bushels per acre, providing the season is favorable. In the same manner, the average yield of barley in California is about 25 bushels per acre. Many good farmers secure 75 bushels, while a yield of 50 bushels per acre is considered commendable. Under the most favorable conditions a yield of 50 bushels of wheat or 100 bushels of barley is not impossible, although it is a rather extraordinary yield.

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EXPECTED YIELDS

The question now arises, how may one estimate the yield which may be used safely as a business guide? If only an average yield of these different crops is obtained, the raiser secures a very modest daily wage plus a small interest on the investment. A man who can produce only average yields of crops will, generally speaking, do better in some other business, or by working for a daily wage for others. An intelligent, thrifty, careful farmer may properly hope to secure twice the average return that is customary under the conditions of his soil and climate, but even this is not a safe estimate on which to do business. Very broadly speaking,—necessarily there must be many exceptions,—a competent farmer may expect to secure an increase of 50 per cent over average yields. To illustrate, the following table may be prepared showing what may be expected in California under average conditions of soil and climate:

	Wheat	Barley
Average yield	13	25
A safe estimate for business purposes	20	40
A good yield which competent men may hope to obtain	25	50
Yield not infrequently obtained under favorable conditions	40	75
Possible but extraordinary yields	50	100

These figures are merely illustrative, but it is probable that they represent a somewhat general law: namely, first, that it is possible to secure, under favorable conditions, a yield that is four times that usually obtained; and, second, that for business purposes, it is not safe to count on securing more than two-fifths of the maximum yield. There are many exceptions to the rule because of varying soil and climatic conditions.

It is not intended to assert that larger returns may not be obtained, but to suggest that if a profit cannot be calculated upon this basis, then further study of the situation is needed before making a purchase. In order to assist a new settler in California, a table has been prepared, from such data as is available, showing the yields that may be expected when the crop is grown by a competent man in a location and on a soil adapted to it. The figures given below may be said to represent the best judgment of those who, through actual experience and observation, are competent to judge. The figures are in no sense official:

AVERAGE, PROBABLE, AND POSSIBLE YIELDS*

	Average yield per acre	A safe estimate for business purposes	A good yield which competent men may hope to obtain	Yield not infrequently obtained under favorable conditions	Possible but extraordinary yield
Wheat, bu.	13	20	25	40	50
Oats, bu.	31	45	60	90	120
Barley, bu.	25	40	50	75	100
Potatoes, bu.	125	175	200	300	500
Alfalfa, ton	3.5	5.0	6.0	9.0	12.0
Grain hay, ton	1.25	1.75	2.0	3.0	4.0
Cotton, Durango, lb.	300	400	500	800	1200
Rice, rough, lb.	1500	2200	3000	4500	6000
Hops, lb.	1500	1800	2200	3000	8000
Beans, field, lb.	1100	1200	1400	2500	3000
Onions, sack	100	150	250	300	400
Sugar beets, ton	9	13	18	25	30
Butter fat, per cow, lb.	150	225	300	350	400
Oranges, box	150	225	300	450	600
Lemons, box	175	225	300	450	600
Raisins, Muscat, ton	0.5	0.75	1.00	1.25	2.00
Raisins, Seedless, ton	0.75	1.00	1.25	1.50	3.00
Grapes, shipping, ton	3.0	5.0	7.0	10.0	15.0
Grapes, Interior, wine, ton	3.0	5.0	7.0	10.0	15.0
Grapes, Coast, wine, ton	1.5	3.0	5.0	7.0	10.0
Olives, ton	1.0	1.50	2.0	3.0	5.0
Walnuts, ton	0.4	0.5	.75	1.0	1.5
Almonds, ton	0.4	0.5	.75	1.0	1.25
Prunes, dried, ton	1.25	1.75	2.5	3.0	5.0
Plums, shipping, crate	250	350	450	650	850
Apricots, dried, ton	0.75	1.0	1.25	1.75	2.5
Apricots, shipping, crate	250	350	450	650	850
Pears, ton	4.0	5.0	7.0	10.0	12.0
Peaches, dried, ton	0.75	1.0	1.5	2.0	3.0
Peaches, shipping, box	300	400	600	800	1000
Apples, box	200	300	500	900	1200
Cherries, ton	1.25	2.0	2.5	5.0	8.0

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* In California the pounds per bushel are barley, 50; corn, 52; oats, 32; and wheat, 60.

The sack equivalent in pounds is neither uniform nor standardized. The variation is due to the fullness of the bags and the volume weight of the grain.

Good plump barley	110–115 pounds per sack.
Second class barley	100 pounds per sack.
Heavy extra wheat	125–150 pounds per sack.
Average wheat	120–135 pounds per sack.
Heavy oats in barley bags	100 pounds per sack.
Light oats in barley bags	85– 90 pounds per sack.
Oats in regular oat bags, about	125 pounds per sack.
Beans	80–100 pounds per sack.
Potatoes	110–120 pounds per sack.

Too much emphasis cannot be placed upon the fact that the figures given in the table above are intended to apply to average land and not to the best land adapted to that particular crop. There are large areas in California where five tons of alfalfa per annum may be deemed a safe estimate and where competent men would not undertake to raise alfalfa if they did not expect six tons per acre. On the other hand, there are some areas where much smaller yields may be considered satisfactory.

The chief purpose of this discussion is to enforce the principle that the large yields which are obtained under very favorable conditions are not a true business guide. It is necessary to recognize frankly that only a fraction of such possible yields are obtained ordinarily in actual practice. The purpose is not to try to state what yield may be obtained under each given condition of soil and climate, but to give a sort of working basis for reasonable estimation. Thus if in a given region on a particular type of soil, one determines that it has been found possible to get a yield of thirteen tons of alfalfa per acre, on the basis of two-fifths previously stated 5.2 tons of alfalfa would be a safe estimate for business purposes. If, on the other hand, eight tons were found to be an extraordinary yield, then 3.2 tons are all that could be safely predicted. However, it must always be kept in mind that the competent man may hope to secure better yields. The second and third columns in the above table are the ones to which the reader should give his chief attention.

INVESTMENT REQUIRED FOR SATISFACTORY INCOME

Persons will differ widely as to what is a satisfactory income. Some arbitrary figure must be assumed, however, as a basis of discussion. All that can here be hoped is to show such relationship as to enable one to forecast a condition that will be satisfactory to himself. Let it be assumed then that a gross income of $4000 per year is desired. The annual gross income from the chief farm crops of the United States is about 16 per cent, or one-sixth of the capital invested. Under these conditions an investment of $24,000 would be required. Only a modest wage and a small interest would be earned. A satisfactory gross income, one perhaps that competent men may reasonably expect to earn, would be 25 per cent or one-fourth of the capital invested. An investment of $16,000 would therefore be necessary. Suppose a gross income of $4000 per year is obtained, what becomes of it? In a general way this sum may be divided into three parts: (1) expenses, (2) interest on the investment, (3) return to the farmer for his management and labor. The latter may be called the labor income. There have been gathered, for example, some data on general farms tending to show that if a man has invested wisely in land and equipment he may pay about 7 per cent of the total investment for a working manager. This is equivalent to saying that a farmer should receive 7 per cent on the capital invested for his management, assuming that he is himself actively engaged either in managing or laboring or both. In reaching this conclusion from data collected, 5 per cent interest on the capital invested was assumed. On this basis the following will result:

For labor income—7 per cent on $16,000	$1,120.00
Interest on investment—5 per cent on $16,000	800.00
For expenses	2,080.00
Total	$4,000.00

One thing that is at once obvious from an examination of the data is that if one must pay 10 per cent interest for money to purchase land and equipment there would be only 2 per cent, or $320, left for labor income. It will be noted that for each per cent which is added to the interest charge an equivalent reduction must be made in the labor income. Thus if the interest is 6 per cent one may expect his labor income to be only 6 per cent of the capital invested. If the interest, is 8 per cent, the labor income will be but 4 per cent. Moreover there is a tendency for the labor income to be further reduced on farms growing a single crop, since such farms furnish employment for a relatively small portion of the year.* However, on fruit farms, this condition is somewhat offset by the opportunity for employment in the packing houses, thereby augmenting the income of the owners and their families. Of course, owners of fruit and other farms, who are not actively employed thereon need not expect to secure more than a fair interest on their investment and then only when intelligently and efficiently managed.

Some surprise may be felt that any definite relation can be assumed between labor income and capital invested. The explanation seems to be that the value of the land rises with the income and thus the interest on the new capitalization prevents the labor income from rising. Thus, if a man buys a farm at $50 per acre and the subsequent income justifies valuing the land at $200 per acre, the interest upon the new valuation keeps the labor income from rising. It is well known that this rise in the value of land has been the source of much profit to farmers.

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* See footnote, page 15.

Of course, very much will depend upon the wisdom with which expenses are incurred. Without doubt there is in individual cases great opportunity for increasing the labor income by decreasing expenses. What this paragraph suggests is that it is not wise to assume a gross income greater than one-fourth the capital invested and that one must concede that one-half the gross income may be required for running expenses. Unless a man can estimate a satisfactory labor income on this basis, it is prudent to proceed with caution. It is obvious that if a man is satisfied with a labor income of $560 per year an investment of $8000 will suffice. If the farm is paid for he may expect a cash income over expense of $960 per year, since he has a right to expect interest on the investment plus his labor income.

SIZE OF FARM

How large must a farm be to furnish a satisfactory living? From what has been said the best practical measure with which to answer this question is the gross income. The area of land necessary to obtain a gross income of $4000 will depend upon the crops raised. Thus, if the land is to be put into barley, from which may be expected 40 bushels per acre, worth 60 cents per bushel, or a gross return of $24 per acre, there will be required 167 acres to return a gross income of $4000. If adapted to potatoes, yielding 175 bushels per acre, worth 70 cents per bushel, 33 acres would be required. An orange grove, yielding 225 boxes, netting the grower a dollar per box, would require less than 18 acres in trees. As there is more or less waste land in all types of farming, it may be stated, in general terms, that 200 acres of land would be required for barley and 40 acres for potatoes, while 20 acres would suffice for oranges. A similar estimate may be made concerning dairying. Estimating a yield of 225 pounds of butter fat per year and that three pounds of butter fat are worth a dollar, the total income for butter fat per year is $75 per cow. Each cow may raise a calf, and some pigs and chickens may be kept. It may be possible, therefore, to secure a gross income from all sources of $100 per cow. The amount of land which is required to keep a cow in California varies at least as widely as from one to ten acres where dairying is now actually practiced. Where alfalfa is grown in the open valleys under irrigation, it requires about 1¼ to 1½ acres to support a cow. Assuming the latter figure, it will require 60 acres to bring a gross income of $4000. It is interesting to observe that in a certain irrigated region tracts of 20 acres each were sold for dairy purposes. As time has gone on the farmers located upon these tracts have acquired additional lands, so that at present the one-family dairy farm, based upon alfalfa, is actually about 30 acres. This is perhaps another way of saying that these families are satisfied with a gross income of $2000 per year.

INFLUENCE OF CHILDREN

The one-family farm just mentioned is a familiar instance of the influence of family co-operation in farming. Various members of the family help on these farms. In this way the labor income is apparently increased and the expense of conducting the farm is decreased. This, however, is merely because members of the family are not paid for this labor at current rates. Nevertheless one of the important reasons for engaging in certain types of farming is that it gives rational and remunerative employment to the children of the family. Farming remains the one great industry where children are a material asset. A man with a family of children may wisely engage in dairying, fruit raising, or vegetable growing, not only because he can use the labor of his children to advantage, but because the training in contributing to the family income which they receive before the age of twenty-one is one of the most valuable assets these children can acquire. If the ideal of a successful home is not a part of the programme it may be well to question whether some other activity may not better engage attention.

THE INFLUENCE OF PRICE

The gross return per acre depends of course, upon two factors—yield and price. The size of the farm required for a given gross return will depend, therefore, not only upon the fertility of the soil but also upon the location. The latter materially affects the price, especially in a state of great size with many communities remote from the larger centers of population. Nowhere, probably, is community effort more important in securing satisfactory prices than with the fruit raiser in California. No matter how satisfactory the yield and quality of the fruit may be, if the grower is not surrounded by others raising a like commodity, usually it will be found difficult to market the crop at a satisfactory price. In the figures which are given in the table it is not intended to state either the lowest price or the highest price at which a given commodity sells in California, but rather to state what men in the industry would look upon as a low or high price. The average price, also, is not necessarily the average of any number of years or of any locality, but rather a statement of what would be looked upon as a satisfactory price by those who are engaged extensively in growing the particular crop in the leading localities where the crop is produced.

ILLUSTRATIONS OF SIZE OF FARM

Table showing the area required to produce a gross income of $4000 per year, assuming the average price stated. The yield assumed is stated in column 2, page 3, under the heading—A Safe Estimate for Business Purposes. Figures are not official.

	Low Price Dollars and cents	High Price Dollars and cents	Average Price Dollars and cents	Size of Farm necessary to obtain gross income of $4000 Acres
Wheat, bu.	$0.70	$1.00	$0.85	235
Oats, bu.	.40	.65	.55	161
Barley, bu.	.50	.75	.60	167
Potatoes, bu.	.50	.90	.70	33
Alfalfa, ton	5.00	12.00	8.00	100
Grain hay, ton	6.00	15.00	10.00	229
Cotton, Durango, lb.	.11	.17	.14	71
Rice, rough, lb.	.01	.03	.02	91
Hops, lb.	.10	.30	.17	13
Beans, field, lb.	.03	.05	.04	83
Onions, sacks	.50	2.00	.80	33
Sugar beets, ton	4.50	6.00	5.50	56
Butter fat, lb.	.25	.40	.33	60
Oranges, box	.50	2.50	1.50	12
Lemons, box	.75	3.00	2.00	9
Raisin, Muscat, lb.	.02	.05	.03	89
Raisins, Seedless, lb.	.025	.06	.04	50
Grapes, shipping, ton	7.00	60.00	20.00	40
Grapes, Interior, wine, ton	7.00	18.00	15.00	53
Grapes, Coast, wine, ton	12.00	30.00	23.00	58
Olives, oil, ton	40.00	50.00	45.00	59
Olives, pickling, ton	80.00	200.00	150.00	18
Walnuts, lb.	.10	.15	.12	33
Almonds, ton	160.00	340.00	280.00	29
Prunes, dried, ton	50.00	120.00	80.00	29
Plums, shipping, crate	.45	1.25	.60	19
Apricots, dried, ton	120.00	300.00	180.00	22
Apricots, shipping, crate	.50	1.50	.75	15
Pears, ton	20.00	60.00	40.00	20
Peaches, dried, ton	70.00	200.00	105.00	38
Peaches, shipping, box	.25	1.00	.40	25
Apples, box	.40	1.50	.65	20
Cherries, shipping, ton	100.00	300.00	200.00	10

A certain amount of waste land must be assumed. The smaller the tract the greater the proportion of waste due to roads and buildings. Allowing some leeway for waste land, it is possible to state, in general terms, that for grain raising, such as barley, oats, or wheat, two hundred or more acres will be required to secure a gross income of $4000 per year where the rainfall is sufficient to permit of annual cropping, and twice that amount will be required where it is necessary to practice summer fallow on alternate years. Sixty acres may be required for sugar beets, grape growing, or dairying. Potatoes and various tree fruits may require forty acres or less. Ten acres appears to be the smallest area on which a California crop will return a gross income of $4000 a year under average conditions. It is not intended to assert that a given crop will require a given area as shown in the last column of the table. In fact, it will probably require in most cases either more or less than the amount stated, because the conditions will probably be above or below the average. Neither is it intended to assert that even though the conditions are only average a suitable return may not be obtained from a less area through greater energy, thrift, and knowledge. Indeed, it is being constantly done; for example, while it ordinarily may take forty acres to produce $4000 worth of shipping grapes, an authentic example was brought to the writer's attention where thirteen acres of shipping grapes in 1913 sold on the farm in bulk brought the owner $4692. This crop did not cost the tenant, exclusive of rent, to exceed $500, including pay for his own labor. This illustration is quoted to show that while statements similar to this one can be made honestly and such cases occur not infrequently, they are not a proper guide for the new settler. A part of the zest in farming in California is that there are such prizes for which one may reasonably strive. What it is intended to say is that if one expects to get greater returns than are indicated in the table, he should be thoroughly convinced that he has more favorable conditions or greater ability than the average. Of course, one may properly be content with a smaller gross income and thus require a smaller area to satisfy his needs. It is fairly obvious, however, that statements of satisfactory income on less than ten acres, which undoubtedly do occur, do not represent normal conditions and are not safe guides for those who desire to make a home in the open country. Such small areas may, and in many cases do, furnish delightful homes for those who have other sources of income. A more delightful place for people of moderate income to live than in some of the valleys of California can be found in but few localities in the world. It is apparent that this type of population is destined to increase largely. Neighbors of unusual intelligence and culture, schools and civic improvements of the highest order, unparalleled climate, and good roads throughout the year, as well as many other factors, contribute to this end.

SOME CENSUS FIGURES

More than three-fifths of all the land owned in farms in California in 1910, was held in tracts of one thousand acres or over. This vast area of seventeen million acres, however, represents only about 5 per cent of the total number of farms. There were less than five thousand farms of over a thousand acres each, while there were more than ten thousand farms of less than ten acres each. More than one-tenth of all the farms in California, 1910, were less than ten acres in area. In many instances, however, the income from the farm did not represent the total income of the owner. The following table gives the number of farms by size groups, together with the total area of land and the value per acre in each group as determined by the census of 1910.

	Number	Total area	Value per acre
Under 20 acres	22,525	200,822	$666.67
20 to 49 acres	20,614	625,954	308.01
50 to 174 acres	22,695	2,462,400	126.03
175 to 999 acres	17,670	7,352,304	59.29
1000 acres and over	4,693	17,289,954	21.84
Total	88,197	27,931,434	51.93

Speaking in general terms, one-fourth of the farms of California were less than twenty acres in area, one-fourth between twenty and forty-nine acres, one-fourth between fifty and one hundred and seventy-four acres, while the remaining one-fourth were one hundred and seventy-five acres or more in extent. The latter one-fourth occupied seven-eighths of the total area in farms. The average size of farm was three hundred and seventeen acres with an average value for land and buildings of $16,447. The average value of livestock per farm was $1447, and that of implements and machinery was $414.

It is interesting to note that farms operated by owners averaged two hundred and twenty-seven acres, by tenants three hundred and forty-two acres, and by managers nineteen hundred and thirty-three acres. The greatly increased acreage value of the smaller farms as shown in the table above is due to many causes, of which four stand out prominently: (1) location, (2) larger proportionate value of buildings, (3) irrigation, (4) in many cases, plantations of fruit trees.

ESTIMATING THE VALUE OF LAND

A Dairy Farm.—How may one estimate the value of land? All that one can hope to do is to give an illustration of a method. For this purpose, the dairy farm, previously mentioned, may be used. It was seen that sixty acres may be sufficient to produce a gross income of $4000 per year where cows are kept on land raising alfalfa by irrigation. According to figures previously mentioned, this would represent an investment of $16,000. This investment may be roughly divided into four parts: (1) raw land, (2) water rights and the preparation of the land for irrigation, (3) buildings, (4) animals, tools, and other floating capital. The animals, tools, and other floating capital may be estimated at 25 per cent of the total investment, or $4000. If the buildings are satisfactory, they may easily cost an additional $4000, thus leaving $8000 for the raw land, for water rights and the preparation for irrigation. It is a matter to be determined in each individual instance, but if the water rights and preparation for irrigation are to cost $2000 on sixty acres, this would leave $6000 which may be paid for raw land, or $100 per acre. Obviously if water rights and preparation for irrigation cost $4000 then only $80 per acre should be paid for raw land. No one must assume that the figures stated necessarily apply to an individual case. Each person must take the principle here illustrated and determine what the figures should be under his circumstances.

An Orange Orchard.—In a paragraph on page 6 it was estimated that twenty acres of land planted to oranges might be required to return a gross income of $4000. According to the basis on which we are working, this represents a capital of $16,000, or $800 per acre. In this instance, probably $2000 may be estimated for the buildings, leaving $14,000 for land, water, and trees. Let it be supposed that the water rights, including water delivered to the highest point of the tract, cost $150 per acre, and the cost of bringing these trees to the age of five years, including the purchase of the trees, planting, cultivation, irrigation, fertilizers, and taxes, is $350 per acre, then the situation would stand as follows:

TWENTY ACRE ORCHARD

Buildings	$2,000.00
Water rights	3,000.00
Bringing orchard into bearing	7,000.00
Value of raw land	4,000.00
Total	$16,000.00

Under this estimate, raw land capable of being irrigated and suitable for growing oranges, may be estimated to be worth $200 per acre. It is not intended to say that such raw land is worth $200 per acre. What is intended is to point out that in finding the value of raw land one should determine the cost of buildings, water rights, and the expense of bringing the trees into bearing, and deduct these items from the value of a bearing orchard.

The influence of yield upon the value of land may be illustrated with the orange crop. Suppose instead of a safe yield of 225 boxes per acre, a yield of twice this amount, or 450 boxes, is estimated, which is a yield not infrequently obtained under favorable conditions. At a dollar a box the area required to return $4000 gross income would be approximately nine acres. As there will be some waste land, let a tract of ten acres be estimated. The cost per acre of water rights and bringing orchard into bearing remaining the same, the following table shows the result:

TEN ACRE ORCHARD

Buildings	$2,000.00
Water rights—ten acres at $150	1,500.00
Bringing orchard into bearing—ten acres at $350	3,500.00
Value of raw land	9,000.00
Total	$16,000.00

It will thus be seen that when the income per acre is doubled the value of raw land rises from $200 to $900 per acre. The same result would have been accomplished if instead of assuming a change of yield from 225 to 450 boxes per acre, the price had risen from $1 to $2 per box. By way of emphasis the illustration may be pushed further: Suppose instead of a yield of 225 boxes per acre only an average yield of 150 boxes, worth $1 per box, was obtained. Then to secure a gross return of $4000 would require nearly twenty-seven acres—to allow for waste land, assume twenty-eight acres. Estimated as before, the following interesting result is obtained:

TWENTY-EIGHT ACRE ORCHARD

Buildings	$2,000.00
Water rights—28 acres at $150	4,200.00
Bringing orchard into bearing—28 acres at $350	9,800.00
Value of raw land	Nothing
Total	$16,000.00

In other words, when raw land, capable of returning $450, is worth $900 per acre, and when returning $225 is worth $200, then land that is capable of returning $150 per acre is worth nothing for the purpose of growing oranges under the conditions named.

If 225 boxes per acre at $1.50 per box are assumed, twelve acres of trees would be required. Assuming the purchase of a fifteen acre tract, raw land would, in accordance with the assumptions already made, be worth $435 per acre.

In like manner, accepting these assumptions, bearing orchards of the sizes named, returning an annual gross income of $4000 each, would be worth:

VALUE PER ACRE OF BEARING ORCHARD

10 acres	$1,600 per acre
15 acres	1,067 per acre
20 acres	800 per acre
28 acres	571 per acre

Since this circular is being prepared for the prospective settler, it is assumed that the tract to be purchased will constitute a home as well as a place of business. The cost of a bungalow of the simplest type, therefore, has been included under the head of buildings. Many of the orange and lemon groves of California, however, are without dwellings, being held by the owners as an investment. (See paragraph, *A Going Concern.*) Even when the owners are not engaged in other business, they often live in nearby towns or villages. Not infrequently there is a dwelling for a foreman or other laborer. The tracts on which owners of homes are located are apt to be twenty acres in extent and yield a gross income of $4000 per year.

Dry Farming.—It has been shown that two hundred acres of land sown annually to barley might bring a gross income of $4000 per year. In the area having an annual rainfall between ten and fifteen inches this result could probably be obtained only by cropping every other year and by the practices known as dry farming. In order, therefore, to obtain an annual income of $4000 per year, four hundred acres of land would be required, so that one-half might each year remain fallow. Assuming $4000 is required for horses, machinery and other equipment, there would be left $12,000 to invest in land possessing suitable buildings, or at the rate of $30 per acre. If buildings are absent then a sufficient sum must be deducted to pay for the buildings. If $4000 is required for buildings, then the land should be purchased at $20 per acre.*

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* For further discussion of land values see page 45.

A Going Concern.—The dairy farm and the orange grove are illustrations of two very different types of business. In the case of the dairy farm the farmer receives his pay check every month. With the orange grower, payment comes in during a restricted period. On a new dairy farm it will take a year to get the farm under full headway. In the case of the orange grove it will take about five years to bring the trees into commercial bearing; that is, into a condition where it will pay expenses. It may not come into full bearing for ten years. Dairying is a going concern almost from the start, while to secure a successful orange grove it requires many years of waiting which can be afforded only by men who have other sources of income. One of the most important questions to determine in the purchase of a piece of property is how soon it will become a going concern. Some banks adopt it as a policy not to loan except to going concerns. The man who must earn a living through his own labor will do well to invest in an orchard or ranch from which he can get immediate returns, rather than to invest in land which will require years to develop. On the other hand, a man who merely wishes to invest capital may easily spend five or even ten years in developing a business farm enterprise. The fact that relatively few men have capital so to invest gives them a greater opportunity to reap eventually a good return.

Side Issues.—It is, however, possible for a man to make himself a going concern by taking up side issues while his orchard is growing. There are two general methods of doing so: one is to grow intercrops in his orchard while the trees are small. The success of this method will depend upon a number of factors, including the kind of fruit, the abundance and cost of water, and market conditions. The other method is to engage in outside work while the orchard is growing. It is a rather common practice in the citrus sections for a man who is starting a grove of his own to care for other groves at the same time; thus a man with a ten or twenty acre tract of his own may have charge of two or three other bearing groves, ranging from five to twenty acres each. It is generally estimated that one man can do the cultural work on forty acres. The considerable number of non-resident owners makes a demand for such services. The smallness of the areas makes the arrangement physically possible.

Diversified Agriculture.—In the illustrations which have been cited it has been assumed that only a single crop was being used. In fact, however, many farms do and most farms should raise a variety of products. A diversity of crops helps to conserve the soil, to keep down insect enemies and fungous disease, and to make possible a more constant and economical use of labor. It may also result in reducing the area required for a given gross income. Assume an average annual yield of five tons of alfalfa per acre at eight dollars per ton. There would be required 100 acres to produce an income of $4000. It has been shown previously that an alfalfa ranch of sixty acres carrying forty cows may give an equal gross income. Thus in the same way the rearing of cattle, sheep, horses or hogs may considerably modify the area required.*

SALE OF LAND

If a person owns a ranch that is profitable he is not generally anxious to sell it. If a man owns a herd of cows and desires to sell some of them he will, if he is a good business man, seek to sell his poorest cows. Lands follow the same economic law. The ranches that come upon the market are apt to be those that have for some economic cause become unprofitable. This may, of course, be due to several reasons. It may be that it is not possible to compete with other lands of greater fertility. It may be that the growth of cities and the development of transportation have made it no longer capable of competing with other areas. It may be due to mismanagement. It may be that changing conditions have made the area too large and that it needs subdivision. However, thoroughly desirable areas may be placed upon the market for various reasons, as through the settling of estates. Frequently splendid areas are brought into the market through the development of new water supplies.

It is a characteristic of California conditions that its soils are what is called "spotted." There may be very poor areas surrounded by land of great fertility. Men who make it a business to buy and sub-

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* Professor Bioletti comments on this paragraph as follows: "Our fruit production seems to show a tendency to get into the hands of men with limited capital—capital too limited to fully develop an orchard of sufficient size to supply the needs of a moderate family. For such cases, it seems to me desirable that the grower should diversify his crops in two ways, first in order to supply his family with as large proportion of their food consumption as possible, and secondly to utilize his own and his family's labor in the harvesting of the crops. Probably at least half of the living expenses of a family can be supplied by the milk, eggs, vegetables, fruit, etc., raised on the place. It would be impossible for any ordinary farmer to harvest a crop of an orchard consisting of one variety of fruit, if this orchard were large enough to support the family and to supply them with employment during the main part of the year. The following is an example of what might be a good choice of diversified crops for a thirty-acre orchard in the central portion of the Interior Valley:

5 acres Apricots for drying	July 1–15	harvest	10 days
5 acres Peaches for drying	July 15–30	"	10 "
5 acres Sultanina raisins	Sept. 1–15	"	10 "
10 acres Muscat raisins	Sept. 15–30	"	10 "
Border trees—			
1 acre trees—Figs for drying	Aug.–Sept.	"	5 "
1 acre trees—Olives for pickling	Oct.–Nov.	"	5 "
2 acres Alfalfa.			
1 acre Buildings and garden.			
30 acres			50 days

divide land will find these less fertile areas offered for sale at much less than the ordinary run of land. For this reason, such areas are often chosen for subdivision. Doubtless the men who purchase these tracts for subdivision are not infrequently mistaken as to their real value, or at least do not appreciate the actual difference in productivity between lands of different qualities. At any rate, what the prospective settler should realize is that because he sometimes finds undesirable properties offered to him, that is no evidence that fertile soils do not exist in California. Such soil may exist on the other side of the fence. California is a state of wonderful fertility and almost unthinkable agricultural possibilities, as anyone who wishes may convince himself by proper investigations.

The purpose of this circular, however, is not to dwell upon the great opportunities of the state, but to point out to the prospective settler the difficulties to be avoided, to the end that his success may be made more certain.

NEED OF WATER

The area over which certain crops can be grown in this state is many times definitely determined by the water supply or the possibility of developing such supply. At least seven and possibly eight of the principal crops mentioned on page 40 of this circular are dependent on irrigation, except perhaps, when grown in some of the more favored localities of the state. The settler should look carefully into everything that pertains to the extent, reliability, permanency, and cost of an irrigation water supply for his farm, as outlined in a subsequent article, page 29.

HARDPAN

Soils should have good depth and good drainage. The need of drainage is hard to appreciate or even determine before the land is irrigated in areas of limited rainfall. One reason why analysis of the soil is of so little value in ordinary practice is that the depth of the soil and the position and character of the hard pan usually affect the productivity of virgin soil to a greater extent than existing variations in plant food. Soils in sub-humid climates are peculiarly prone to possess layers of hard pan. These layers are very irregularly laid down. Hence, a minute examination is required to determine its extent and possible injury on a given piece of land. The United States Bureau of Soils has, on account of these structural differences, adopted the rule of examining a cross-section of the soil to the depth of six feet in western United States, while elsewhere three feet has been deemed sufficient.

DRAINAGE

Without natural or artificial drainage, alkali is the inevitable consequence of irrigation wherever the evaporation from the soil is greater than the rainfall. "Irrigation without proper provision for drainage has, in the past, in very many cases, been the cause of abandonment of lands once abundantly fruitful."*

Without stopping to go into the matter exhaustively, it may be said in general, that those lands most likely to be brought under irrigation are the areas which usually lack good natural drainage. In humid sections the water table may be within three or even two feet of the surface without injurious results. In arid sections the water table should be not nearer than five feet from the surface, while a depth of six or more feet is desirable. This is due to the deeper feeding area of the roots of plants in arid climates as well as greater danger from alkali where the water table is near the surface. No prediction can be made as to the length of time which will elapse before alkali will appear under irrigation. Clay lands usually suffer sooner than sandy ones. There are areas that have been irrigated for more than twenty-five years which do not yet show the need of under drainage. The purpose of this paragraph is merely to warn purchasers of irrigated land that they may be required to add to the purchase price the cost of tile drainage. A complete system of tile drainage may cost as much as forty dollars per acre, while it is possible that sufficient drainage may be afforded in other cases at a cost not to exceed ten dollars per acre.

Excellent opportunities exist today for the purchase and reclamation by tile drainage of lands that have "gone bad" under irrigation. The intending purchaser should be cautioned, however to try to reclaim only lands which are known to have been fertile. Lands which have never been known to have grown profitable crops may well be avoided in the present state of our knowledge.

GOOD AND BAD LANDS

The goodness or badness of land is largely in relation to the crop it is intended to grow. Thus there are soils excellently adapted to olives which will return poor yields of wheat or barley. There are vast areas in California well adapted to grains and alfalfa, on which potatoes cannot be grown economically because of the character of the soil, and on which oranges and lemons cannot be grown on account of the danger of frost. Certain lands which are adapted to raising olives are not worth, and in the past, have not been valued at more than five dollars per acre for other types of farming, are now valued and may be worth one hundred dollars per acre for olives. The fact that lands are valued at much higher prices when adapted to oranges, lemons, or alfalfa than when adapted to grains has led to the placing upon the market of a great deal of land for crops to which it is not adapted. The land is good enough when used for the purpose to which it is adapted, but it is bad when an attempt is made to use it for some other purpose. Certain areas may be very good land when purchased at five dollars per acre for grazing purposes and equally bad land when purchased at fifty dollars per acre for alfalfa, or five hundred dollars per acre for oranges. Yet there are lands that are good when purchased at five hundred dollars for oranges and others that are good when purchased at fifty dollars for alfalfa. The sale of land for purposes to which it is not adapted, and at prices which its adaptation does not justify, has caused greater losses and greater misery than any other thing connected with land settlement.

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* See article by Dr. Hilgard, entitled "Alkali Lands—Irrigation and Drainage in Their Mutual Relation," in the Report of the California Agricultural Experiment Station for the year 1890.

The College of Agriculture has definite information concerning types of soil and their adaptation for only a portion of the state. For such portions as are known only statements concerning crop adaptations for the type in general can be furnished. No assurance of economic returns can be made. Persons wishing information with reference to any tract should state specifically the number of the section and the quarter section to which reference is made. This information is not for the purpose of passing upon the value of the particular tract but for the purpose of determining to what soil type the tract belongs.

PURCHASE OF LAND

A person buying farm land in California seldom deals with the owner. This is especially true where large tracts are subdivided and sold to settlers. The owners of such tracts ordinarily place their holdings in the hands of a real estate firm who, of course, handles the sale on commission. But even the members of the real estate firm seldom, in the case of these large holdings, make the sale in person. The real estate firm employs agents of a more or less itinerant character who make the actual sales. Under the present system, the agent with whom the purchaser deals is not infrequently an irresponsible party and cannot be found later to substantiate the statements made. It is therefore absolutely necessary for the purchaser to act only on evidence confirmed from other sources and to sign no contracts that he does not fully understand and cannot fully verify, and to be absolutely certain his titles to the land and to the water rights are satisfactory.

Just as elsewhere in the United States, there are persons, firms, or corporations which make it their business to abstract titles. In California, such a person or agency is not usually called an abstractor of titles but a searcher of records. On smaller transactions, moreover, it is not customary to insist upon an abstract of title, but to secure in place of it a certificate of title, which is in effect a statement by the person, firm, or corporation that it has examined the title and certifies that it is valid or if the title is not clear states in what way the title is clouded. In some of the larger towns may be found an office, perhaps next door to the bank, over which is the sign "Title Bureau." This means that the searcher of records has qualified under the state law to issue for an additional fee a policy of title insurance. While the searcher of records is not a public officer or the title bureau a public agency, they, at present constitute the accepted method of securing advice concerning land titles. Under existing conditions, the new settler will do well to secure title insurance before purchasing land.

HOW TO LOCATE

Probably nothing can make a man keen in a horse trade save experience. No law can furnish a man with judgment. The United States and the State government are endeavoring to furnish information on which men may base sound judgment if they are level-headed and already have some knowledge of farming. Persons with no knowledge of farming are advised not to purchase farm lands in California until some months of experience have brought them into actual contact with conditions. It is, of course, important to "help the investor as much as possible through supplying accurate data, but the buyers must assume some of the responsibility when they buy without attempting to inform themselves." Detailed soil surveys of certain counties of California have been made by the United States Bureau of Soils and more recently a reconnaissance soil survey of California has been begun by that bureau in co-operation with the California Agricultural Experiment Station. At this writing a map of the Sacramento Valley, involving four and one-half million acres, has been completed, and the other areas of the state will be completed as rapidly as possible. These reports give an accurate and authoritative description of the various types of soil, their adaptation to different crops, their methods of management, and their ordinary commercial value. Wherever they are available they should be studied before lands are purchased. The California State Immigration Commission, with offices at the Underwood Building, San Francisco, will assist those seeking to purchase land, as will also the California Development Board, with offices at the Ferry Building, San Francisco. Both these public agencies have gathered a fund of detailed information which is free to all who may apply. The College of Agriculture of the University of California may, through its several stations and employees in different parts of the state, be of service to those who desire to obtain a home on the land. Many of the counties maintain, through public taxation, boards of trade or chambers of commerce. If one has decided, through information received from other sources, to locate in a given county, assistance in locating within the county may be obtained usually by addressing a letter to the secretary of the board of trade at the county seat of the county. A number of counties also maintain a county commissioner of horticulture, who has intimate knowledge of fruit growing within his county and may usually be addressed at the county seat.

There are, including branch and deposit stations, and excluding professional libraries, about 950 libraries in California. Most of them are open to the public for reference purposes. All these libraries receive the publications of the California Agricultural Experiment Station and some of them contain other references on agriculture. By consulting the librarian, suitable references concerning the leading features and methods may be obtained. If you want the help which books can give you ask the librarian to assist you. No one who comes to California to locate upon the land need go without reasonable authoritative and accurate knowledge, if he consults the various sources of information which have been mentioned and which are ready without a charge to serve the prospective settler.

CLIMATE AS AFFECTING CROP PRODUCTION*

Owing to its topography, prevailing winds and proximity to the ocean, California is subject to a very wide range of rainfall, temperature and humidity, and owing to the same reasons the entire range of these phases of climate may be comprehended in the several large divisions into which the state may be divided.

To those coming from regions east of the Mississippi Valley two features of the climate of California will be noticeable: First, the season of greatest rainfall is in the winter months, the months of June, July, and August being almost devoid of rainfall. Second, the lines of equal temperature run for the most part north and south, rather than east and west.

So far as climate in its bearing on crop production is concerned, the state may be divided into five sections, but even in these divisions there will be some climatic features common to all.

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* By E. J. **Wickson**, Professor of Horticulture.

The map on the last page indicates divisions of the state according to the prevalence of similar climatic conditions which roughly determine agricultural adaptations, viz.:

1. Northwest Coast Region.
2. Central Coast Region.
3. Southern Coast Region.
4. Interior Valley Region.
5. Mountain and Plateau Region.

The Northwest Coast Region.—This section is mountainous, being covered principally by the Coast Range. The valleys are relatively small and irregular. The important climatic features of this section are the moderate temperatures throughout the year, the high annual rainfall, and the prevalence of high winds and fogs along the coast.

At Eureka in Humboldt County the highest temperature recorded is 85.2 (June 6, 1903), while the lowest is 20 (January 4, 1888). In most portions of this section the rainfall varies from 40 to 100 inches. This variation, however, is mainly due to elevation. It should be noted that from year to year the rainfall may vary in any one place more than 100 per cent, and as stated above it is always smallest in July and August.

This section most nearly resembles the east-north central and middle Atlantic states in its agricultural operations and possibilities. It is eminently suited for the production of forage grasses and clover and to dairying, and has also demonstrated success with several fruits in proper soils and exposures.

The Central Coast Region.—This region includes coast slopes, many small valleys and a few of considerable size, and a large area of foothills and mountains west of the high ridge of the Coast Range, which at several points attains an elevation of about 4000 feet. Among the valleys are those of the San Francisco Bay district—the pioneer regions of commercial crop-growing and which now constitute one of the largest highly developed and densely populated agricultural districts of the state. Central in this district lies the City and County of San Francisco, which enjoys the unique distinction of having produced the tallest sky-scrapers and the broadest cabbage fields in the state. North of San Francisco are the coast valleys which are great producers of dairy and poultry products, fruits and field crops, and south of San Francisco are the bay-shore valleys long noted for truck-crops, fruits—the prunes of Santa Clara and the apples of Pajaro valleys—and the hay, grain, and sugar beets of Salinas and Santa Maria valleys, while adjacent hill lands are largely used for grazing and, on the coast side, for the dairy industry.

The Central Coast Region is very diversified in topography, intermediate in temperatures and rainfall between its neighboring coast districts north and south, and it has a range of products wide as the state itself, except that citrus fruits are not commercially produced, although grown by amateurs at favoring elevations and exposures.

The Southern Coast Region.—This region extends from the point where the coast takes a sharp eastward turn and proceeds southward to the southern boundary of the state. Its width is determined by the distance of the high ridge of the Coast Range from the ocean—narrow at the west, increasing toward the central part, where the San Gabriel and Santa Ana valleys extend northerly and easterly to the foot of Mt. San Bernardino, and then narrowing again to its southern limit just below San Diego Bay. Owing to its environment and exposure, as well as its latitude, this region has more heat than the more northerly coast regions, though in its extensions away from the ocean it has had in some places and at long intervals a brief drop in temperature to a degree as low as other valleys with similar elevations. It is on the whole, however, most equable in its temperatures and by this widely known characteristic has attracted settlement and development in some respects beyond other districts of the state. The products of the district are large and various, including most of the present production of citrus fruits and walnuts, most of the beans, much of the sugar beets and truck crops for overland shipment and dairy, poultry, hay, grain, and orchard fruits for a part of its local consumption. It is for the most part an irrigated district, though some crops are successfuly made along the coast by rainfall.

The Interior Valleys Region.—This region extends from the north end of the Sacramento Valley southward through the length of the San Joaquin Valley to the Tehachapi Mountains, which form its southern boundary. This pair of connected valleys constitute what is properly called "The Great Valley of California," about 400 miles long and from 40 to 60 miles wide. It contains a larger body of productive land than any other subdivision of the state. Central on the west side of the Great Valley are the deltas of the two great rivers whose names designate their respective valleys. The break in the Coast Range which gives outlet to their waters to the Bay of San Francisco, also admits an interior extension of coast influences which modify climatic conditions over these deltas and adjacent lands, as is indicated by the circular intrusion of Division 2 into Division 4 as shown on the map. This circular area is somewhat different in climatic characters, however, from that of either of the divisions to which it is related, for it is a blending of the two.

In the extreme southeast part of the state is another area marked Division 4 which is thus connected with the Great Valley because it has closer resemblance thereto, both in characters and products, than to any other region of the state. It comprises the Imperial Valley and other valleys adjacent to the Colorado River. It differs from the Great Valley in having a higher temperature both in summer and winter and in its rainfall, which is practically negligible, as all cropping is conditioned upon irrigation.

The Great Valley differs from the coast regions west of it in having a lower winter temperature, because its dominating environment is the snow-clad Sierra on its east side, while the dominating environment of the coast is the ocean. This contrast is more marked through the central and southward stretches of the Great Valley. Another contrast is found in summer temperatures which may average more than twenty degrees higher on the east than on the west side of the Coast Range, because the ocean then has a cooling effect upon the regions open to its influence.

In rainfall the Great Valley has such marked differences that generalization is impossible. Roughly speaking the Sacramento Valley may be said to have from 20 to 40 inches of rainfall in different years, while the San Joaquin has from 4 to 16. This variation in rainfall is, however, overcome by irrigation which is practiced in the Great Valley over a greater acreage of land than in any other region of the state. The products include all grown anywhere in the state.

The Mountain and Plateau Region.—It has been found by observation during many years that what are known as valley conditions prevail to an elevation of about fifteen hundred feet over the rolling region known as the ''foothills''—which are the steps up to the high ranges. Above this elevation winter temperatures fall lower, rainfall increases, snow flurries begin, and thence upward mountain valleys and plateaux are found at different levels up to about six thousand feet, which is about the top of California's agricultural lands, and above four thousand feet such lands are used principally for summer pasturage. This mountain region has a winter like that of the eastern states with a great precipitation of rain and snow to cause great rivers to flow down the west side of the Sierra and give the state its invaluable and ample water supply for power and irrigation. In the valleys among the great snow mountains there are farming districts of considerable present production and great future promise. The most marked character of these high lands is the limitations placed upon cropping by the short growing season and the frequency of frosts during the spring and, at the higher elevations, even during the summer months. Therefore this division differs most markedly from other California regions and has closer resemblance to some of the interior states than to the coast and valley areas of our own state. In this region there is a modification of low temperatures from the north to the south, for the mountain region is more open to the influence of north and south latitude and is not so fully dominated by local topography and ocean influences, which give to the rest of the state its unique climatic characters.

CHARACTERISTICS OF CALIFORNIA SOILS*

In the humid regions of the world, and especially in the humid region of the United States, practically nine-tenths of the soils are either of residual or of glacial origin. The glacial soils have been transported and deposited by ice, and while the glacial deposits may be very deep, the true soil is not deep. The subsoil is usually heavier than the surface, often clayey, and the practical feeding depth of roots is usually less than four feet. The residual soils are much more extensive than the glacial soils. They are formed by the destruction of rock masses, the disintegrated and decomposed fragments accumulating on the surface of the hard rock to form the soil mass. Residual soils usually have a surface soil six or eight inches deep, resting on heavier material that grades to a clay at two or three feet in depth. At greater depths rock fragments are found in the clay and these grow more numerous until the mass is largely broken or "rotten rock," and finally the solid rock mass is reached. (See Fig. 2.) The total depth of the soil mass above the rock varies greatly, but usually is less than four feet.

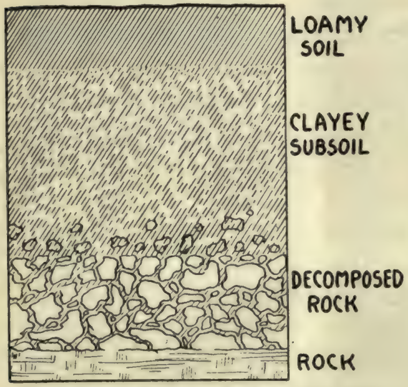

Fig. 2.—Section of a typical residual soil showing gradation from soil through clay, rotten rock to solid rock.

In the humid regions, the transplanted soils, other than those formed by glacial action, are of little extent. The flood plains and bench lands along the rivers and creeks are exceedingly productive, but their total area is small compared with the residual and glacial soils.

In California, as in all sub-humid regions, the residual soils available for agriculture are of limited extent. They are found on hill slopes and on mountain sides and their topographic position makes irrigation exceedingly difficult or impossible, while the shallow soil mass makes

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* By **Charles F. Shaw**, Professor of Soil Technology.

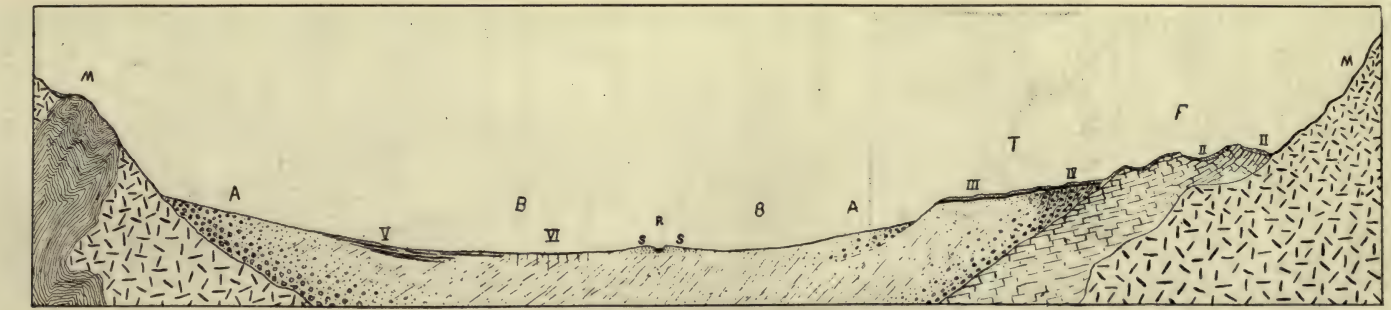

Fig. 1.—Typical section of a California valley. *M-M,* Mountains on either side of valley, washed bare of soil. *F,* Foothills with residual soil (Fig. 2). *T,* Old, eroded alluvial fan, now a terrace, usually with hardpan (Figs. 3 and 4). *A-A,* Alluvial fans, usually gravelly and sandy near the mountains and silty and clayey on the flatter slopes; usually free from hardpan except on some of the older and flatter slopes (Fig. 5). *B-B,* Nearly level flood plain and basins, usually with heavy (clayey) soils, often with adobe structure (Fig. 6) *R,* River with built up banks, *S-S,* of sandy and silty soils

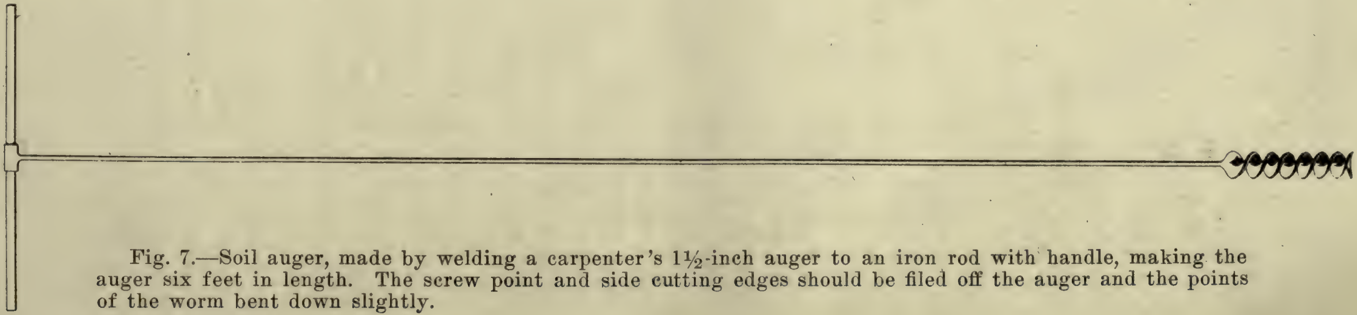

Fig. 7.—Soil auger, made by welding a carpenter's 1½-inch auger to an iron rod with handle, making the auger six feet in length. The screw point and side cutting edges should be filed off the auger and the points of the worm bent down slightly.

dry farming precarious. In the Coast Ranges and on the Sierra foothills are some successfully farmed residual soils but their total area is relatively small.

By far the larger portion of the agricultural lands in the state are transported soils. For uncounted ages the winter rains have been washing the rock fragments from the mountain sides and carrying the material out to the valleys, spreading the mass out as broad sloping alluvial fans or as relatively flat valley floor. The accumulation of sediments in the valleys is often hundreds or even thousands of feet deep (Fig. 1).

Soils formed in this way may be quite uniform to great depths or may be made up of successive layers of varying texture, sands, silts, gravels or clays. As the soils are laid down a little at a time, year after year, they have been acted upon by the weathering agents, breaking up the particles and making the plant food quite available. Under the climatic conditions that exist, with the hot dry summers and the low rainfall coming in winter, the weathering action of air and water, the beneficial action of bacteria and the formation of humus in the soil, occur to considerable depths. Roots ordinarily penetrate to depths of six to eight feet below the surfaec. In studying the soil, it is necessary to consider at least a six foot section instead of the usual three foot section of the humid regions. The climatic conditions of the region and the mode of formation of the soils, have brought about many features that are not common to the soils of a humid region. Owing to the lack of rain, the soils have never been subject to any degree of leaching and most of the soluble materials have been left in the soil masses.

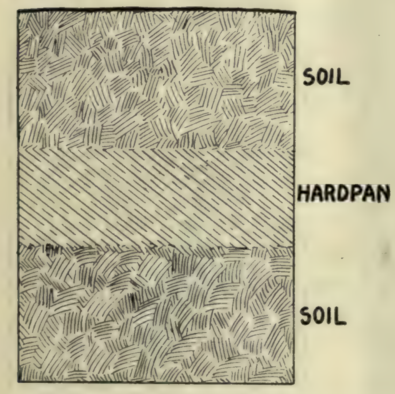

Fig. 3.—A hardpan layer with loose soil material beneath it. Breaking up the hardpan will allow roots and water to enter the substratum of good soil.

Hardpan.—Where the soils are old and have been subjected for thousands of years to an annual rainfall that has wetted the mass to a depth of only two or three feet, some of the soluble material has been carried down and deposited, cementing the grains together to form a hardpan. In this way, the iron and lime-cemented hardpans common to the older, thoroughly weathered, red and brown soils, have been formed. In most cases, the material beneath the hardpan is loose soil very similar to that above the hardpan (Fig. 3), and if the pan is broken by dynamite or other means, irrigation waters and plant roots will readily work down into the underlying soil mass. In such cases the hardpan is not a serious factor as it ordinarily recements very slowly. In some cases the hardpan is underlaid by a compact, semi-cemented layer of soil, sand and gravel that is practically impenetrable to water or to plant roots. (See Fig. 4.) With such soils, dynamiting the hardpan is of little or no value as there is no good soil beneath for the roots to penetrate and no opportunity for drainage or aeration through the substratum.

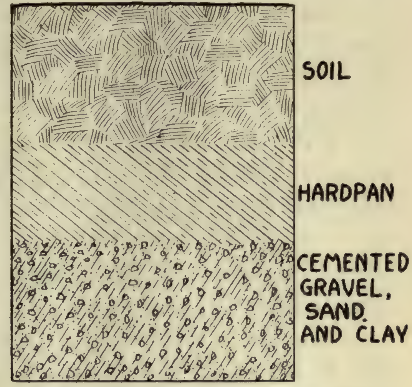

Fig. 4.—Hardpan layer with compact material beneath. Breaking the hardpan will be of little benefit because of the cemented nature of the substratum.

There is another class of hardpan that has been formed at the same time that the soil was formed. This occurs where variations in the soil-forming activities caused a layer of soil to be deposited, then a layer of material that cemented to a hardpan, then another layer of soil, another layer of hardpan, and so on. (Fig. 5.) These hardpan layers are hard to handle, as blasting is not satisfactory unless each of the layers is broken. The hardpan layers do not, however, exist as continuous sheets because in the process of formation of the soil, portions were washed away, the space being filled with other soil material. This, together with the fact that the hardpan is often cracked and sometimes rather soft, gives opportunity for irrigation water and plant roots to penetrate to considerable depths.

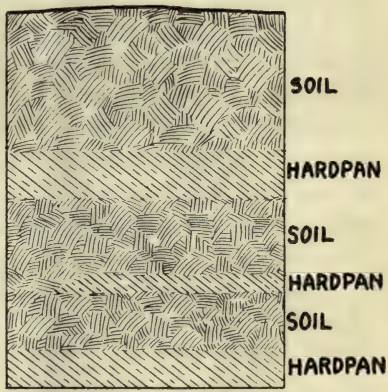

Fig. 5.—Soil with several layers of hardpan with soil between the layers.

Alkali.—Wherever the drainage conditions are poor and there is a larger amount of water passing from the surface by evaporation than passes down through the soil mass, there is the possibility of an accumulation of soluble material or "alkali" on the surface. The term "alkali," as ordinarily used, includes any soluble materials present in sufficient quantity to be injurious to plants. The most common materials are sodium chloride or common salt, sodium sulphate or glaubers salt, and sodium carbonate or washing soda. This "alkali" is not necessarily brought into the soil from some other location. It is merely a regrouping of the chemicals that existed in the original rock, and the concentration of these compounds in the surface soil because of excessive evaporation.

If the soil has good natural drainage, any excess of water will percolate through the soil and will seep out to the country drainage channels, carrying with it in solution, small quantities of the soluble salts. In such cases, the waters evaporated from the surface cannot exceed the amount that passes down through the soil, and alkali accumulations cannot occur.

If the natural drainage conditions are not good, artificial drainage will be necessary if the land is to be irrigated and farmed. In arid regions, the irrigation of poorly drained lands will produce conditions that will ultimately bring about the accumulation of injurious amounts of alkali. It is necessary to study the drainage conditions carefully, noting the character of the soil with respect to permeability and the penetration of water, the character of the substratum, the slope of the land and the possible outlet for drainage waters. The possibility of drainage waters seeping into the soil from higher lying lands should also be investigated.

Texture and Structure.—The texture and structure of the soils need considerable attention. Because of the low rainfall and absence of leaching, the coarser soils, sands, and sandy loams are much more productive in an arid region than are similar soils in a humid country. If the soil is too loose and open, however, there is a great difficulty in irrigating, owing to excess seepage and in addition the humus is readily "burned out" and lost. On the other extreme, the clays and clay adobes are so compact and impervious that they are very difficult to irrigate, the water penetrating very slowly. Such soils are also difficult to till and to maintain in a proper state of firmness.

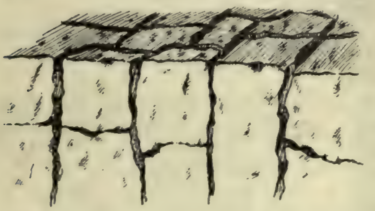

Fig. 6.—An adobe soil, on drying, shrinks markedly and breaks into blocks, with wide cracks between.

The term "adobe" does not indicate a specific kind of soil but refers to the structure. There are clay adobe, loam adobe, and even sandy loam adobe, although the latter is very rare. The name is given to any soil which on drying shrinks markedly and breaks into blocks with wide cracks between. (See Fig. 6.) An adobe structure is undesirable because the soils dry out, not only from the surface but also from the sides of the wide cracks. In irrigating, the water must first fill the cracks and then slowly soak into the hard baked block.

On wetting, the blocks swell up and close the cracks, which reopen again on drying. Considerable injury to plants may occur through the breaking of roots that cross the lines of the cracks and through the drying of many of the feeding roots.

The soils of California are exceedingly productive. They may be compared to the rich bottom lands of the humid regions. The unfavorable conditions that may exist, such as hardpan, alkali, poor drainage, poor structure, etc., can be readily recognized. The presence of alkali can be determined by chemical means or by noting the character of the vegetation and the condition of the surface soil. Drainage conditions, texture and structure, and the presence of hardpan can be determined by examining the soil, boring in it with a soil auger (Fig. 7). The prospective settler should not be content with the examination of the surface soil, but should bore frequently, examining the soil to a depth of at least six feet and carefully noting conditions, bearing in mind that plants that would in a humid region send their roots two or three feet into the soil, will here have a root penetration of six to twelve or more feet.*

IRRIGATION†

As a general rule, irrigation is either a valuable aid to agriculture or a necessity throughout California, so that the settler should look carefully into everything that pertains to the extent, reliability, permanency, and cost of an irrigation water supply for his farm.

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* Dr. E. W. Hilgard writes: "While much detail cannot of course be given within its scope, I think the part dealing with the selection of land should be somewhat enlarged, as being of prime importance, and in some respects most likely to give the newcomer from the humid region trouble.

"First, I think it should be told him somewhat more definitely that the light sandy and silty nature of our soils is not, as would be the case in the East, a sign of poverty, but that these are among our most substantial lands. And as he will naturally be looking for a 'substantial subsoil,' he should be told that the surface soil here is not from three to nine inches deep, but that it counts by feet, usually three or more, and the absence of a subsoil does not mean that the land will be 'leachy,' but is a distinct advantage for root penetration. He should also be told that a gray soil in California is not necessarily poor in humus, and that the surface foot very frequently contains less humus than the second and third foot, where the development of the roots, from the decay of which the humus is usually derived. is most copious.

"The somewhat elaborate discussion of hardpan may lead the newcomer to believe that hardpans are the most prominent features of California soils; whereas the great depth and uniformity of soil masses is certainly the most characteristic feature of the bulk of California lands."

† By FRANK ADAMS, Irrigation Manager, Office of Experiment Stations, U. S. Department of Agriculture.

For the most part it is no longer possible in California to obtain independent individual water supplies for irrigation by direct diversion from streams. In general, therefore, the settler must obtain his irrigation water (*a*) by residence within a municipal irrigation district, within which all landowners share equally in the district water supply, and all legally qualified voters have an equal voice in its control and management; (*b*) by purchasing stock in a mutual, non-profit-making, water company having water available, in which case the water usually becomes appurtenant to the particular farm or the particular tract irrigated, and the water users immediately or ultimately (depending on how much land within the tract or project has been sold) control the water system; (*c*) by contracting with a commercial water company for water service, sometimes requiring the purchase of a ''water right'' apart and separate from the land title; or (*d*) by means of a well and pumping plant developed or to be developed on the farm purchased.

No water company can deliver more water than it controls and the company undertaking to furnish water, whether it be a mutual company or a commercial company organized for profit, should be required to give evidence that it has not ''over sold'' its supply. Care should be taken to see that the water company ''bought into'' has in it the elements, including the financial resources, of regular and reliable water service. If the settler is counting on obtaining his irrigation supply from a well on his own farm he should take all possible means to satisfy himself that a well will yield a sufficient supply of good water at a depth from which he can afford to pump. Publications of the Office of Experiment Stations of the United States Department of Agriculture and of the Water Resources Branch of the United States Geological Survey will help in this regard.

The cost of irrigation water should not be overlooked when figuring on the cost of developing a California farm. In irrigation districts this cost is paid in the form of taxes levied to meet the expenses of operation, maintenance, and betterments, and the interest, and ultimately also the principal, on outstanding bond issues. This may and usually does amount to several dollars per acre per year. In the case of mutual water companies, both the initial cost of the water stock (this is sometimes included in the cost of the land) and the annual assessments or water charges are involved. In some parts of Southern California shares in the mutual companies cost at the rate of $125 to $250 per acre. The annual cost of water to the irrigator obviously includes both interest on this original investment and the annual maintenance and operation charge. Where ''water rights'' are purchased separately from land their cost, in the main central valley, varies from

$5 to $20 per acre and the annual charge from 50 cents to about $2.25 per acre. Where water is paid for by the acre-foot (the quantity that will cover one acre one foot deep), $1.50 is not an unusual charge, although it may be more or less. Where it is paid for by the miner's inch (11¼ gallons per minute according to California statute; nine gallons per minute—the original miner's inch in California—in Southern California), it may cost a few cents or it may cost 50 or 60 cents per inch running continuously for twenty-four hours, totalling from about $5 to $20 or more per acre per year. Obviously only products yielding a high gross return will justify the larger of the charges mentioned. If an individual pumping plant is to be installed the usual initial cost of installation for a forty-acre alfalfa farm will vary from, say, $25 to $40 per acre where the lift does not exceed 50 feet. Circular No. 117 of this Station gives information about the installation and cost of small pumping plants.

The amount of water needed for irrigation in California cannot be stated definitely in a few words because it varies so widely, chiefly according to soil and crop. When bargaining for certain quantities settlers should know whether the water is to be measured at the point of use or at the point it is taken from the canal, possibly one-half mile away, for transit losses from small earthen ditches are sometimes very large. For alfalfa in the central valley probably 2½ acre-feet per year is an average requirement; very heavy soils will not always absorb this amount and very light soils ordinarily receive more, the use of 4 acre-feet per year not being uncommon and sometimes apparently not unreasonable. Grain and cultivated field crops, such as sugar beets and potatoes, need less. Deciduous orchards mostly get along well with about 1 acre-foot, net, per year, where the land irrigated is not too steep and it is well cultivated; citrus orchards sometimes receive as little as 0.8 acre-foot per year (say 1 miner's inch to eight acres irrigated), but more frequently are given twice that amount. Settlers should not be satisfied to accept less water than well-kept and successful farms in the neighborhood chosen are receiving.

Finally, the settler without irrigation experience should not expect to learn the art of irrigation all at once. With land well prepared, however, practice will soon enable him to work with the necessary efficiency, but he must wisely choose both his methods of preparing land and his methods of applying water.

FARM LABOR

Anyone who desires to employ labor or to secure farm employment needs to understand that the early ranchers of California were largely of Southern origin and naturally brought with them the traditional relations between the employer and employed to which they were accustomed, although the employed have not been negroes to any considerable extent. The size of their enterprises, sometimes gigantic, the character of the climate and the variety of the population, have tended to maintain these distinctions. There may be several social strata on a single ranch. The relation between farmer and farm hand which has largely existed in northeastern United States does not obtain ordinarily in California. No one can understand the farm labor problem unless he recognizes this important fact. It is both social and economic, and both factors are different from many other, perhaps most other, parts of the United States. The farm labor problem in California is a cross between Mexico and Georgia traditions, supervised in these later days by the New England intellect.

There are three classes of white farm labor in California. The regular native farm hands, although employed by the day, are regarded as regular employees, being furnished board and lodging. Usually they are teamsters, as few foreigners know how to handle the six and eight horse teams which are the pride of the native California farm hand. The class of labor is satisfactory and reliable. The second class is the transient or hobo, who may or may not be a native American. They are available during harvest and other rush times. This class sleeps in its own blankets wherever circumstances permit, but is usually furnished meals by the ranch. The third class of white labor consists of the foreign immigrant, who has come to this country to make a home of his own. He may be Italian, Russian, Portuguese, Armenian, or of other European nationality. Italians are disposed to work in the wine vineyards and dairies; Portuguese in dairies and on vegetable and deciduous fruit ranches; Russians in the hay field and at grape picking. Italians and Russians prefer contract work, especially in the grape harvest, but may be hired by the day. Nearly all contract laborers care for themselves in camps or other quarters furnished by the ranches. Oriental labor consists of Chinese, Japanese, and Hindus, of which the Japanese are at present most abundant. The Japanese and Chinese prefer working by contract or piece work wherever possible. Nearly all the grape crops are harvested in this way. Labor is furnished by an Oriental contractor, who gets his profits from commissions and board. The Japanese and Chinese always lodge and board apart from other nationalities. These races can outstrip any other class of laborers in grape picking and similar forms of work, because of the Oriental habit of "squatting."

Aside from the employment which is constant in diversified farming, the seasons of employment in the central San Joaquin Valley are as follows:

The farmer's season may be said to begin in October and November, at which time the plowing, preparation of the land, and the seeding of barley and wheat occur. Where citrus fruits are raised, harvesting goes on at this time.

During January and February: Vineyard and orchard plowing and pruning; alfalfa seeding and late grain seeding.

During May and June: Grain hay harvest. The first alfalfa harvest also begins at this time and continues until October.

During, July, August, and September: Shipping grapes and deciduous fruits are harvested.

During September and October: Muscat or raisin grapes and the wine grapes are picked. Figs are harvested.

The working rate of wages existing in 1914 in the central San Joaquin Valley is reported by Mr. S. Parker Frisselle, who has furnished much of the information concerning farm labor, to be as shown in the following table:

PRICES OF FARM LABOR

General ranch labor—	
Winter months	$1.25 to 1.50 per day
Summer months	1.50 to 2.00 per day
Hay and alfalfa harvest	1.75 to 2.75 per day
Fruit harvest	1.75 to 2.75 per day
Muscat grape picking	2.50 to 3.00 per 100 trays of 20 to 22 lbs.
Wine grape picking	1.75 to 2.25 per ton
Vine and tree pruning	1.50 to 2.00 per day

Excepting the piece work given above, all figures include board. Board on ranches in this district is figured at fifty cents per day.

GETTING STARTED

Assume a man has $5000 to invest and that he desires eventually to secure a gross income of $4000 per year, but is willing to accept less in the beginning, how is he to proceed? The discussion which follows is intended to suggest that a person with a small or insufficient capital, by economy and self-sacrifice, may achieve a satisfactory competence. The main items to be considered in estimating the probable or possible outcome are illustrated by a concrete, although imaginary, example. In order to caution the reader against taking the figures here mentioned too literally, there follows a discussion of the application of the particular illustration to existing conditions.

Whether the figures apply to any given place or time is wholly immaterial so far as the involved principles are concerned. The intelligent reader will realize that yields and values will vary with the locality and that what is true of prices of land and products today may not be true tomorrow. The purpose of the discussion throughout the circular is to state principles and methods by means of concrete illustrations. Its value to the reader will depend upon his ability to apply the principles and methods suggested to the particular conditions which he may meet.

First Year.—The first act should be to set aside $500 for family expenses during the first year. Assuming the purchase of sixty acres of undeveloped land with water rights attached at $100 per acre, or a total of $6000, he may pay $1000 upon the land, set aside $1000 for buildings, $1000 for teams, machinery and tools, and $500 for running expenses, including water charges. He may purchase a four-horse team and will spend most of the first year in leveling, checking and seeding his land. He has left $1000 with which to buy ten cows, a couple of sows, and a few chickens. Most of these will be purchased during the latter part of the year and not more than $300 cash income should be assumed during this year.

Second Year.—Since the owner is now going to get his pay check every month, he may pay the interest on $5000 at 6 per cent with the $300 and meet his family and running expenses out of current income. During this year his cows, bull calves, pigs and chickens may bring in a thousand dollars, while another thousand dollars may be received from the sale of alfalfa. Assuming running expenses to be $700, living expenses $500, and interest $300, there is left $500. With this sum five cows and a bull may be purchased.

Third Year.—This year the return from dairy products and livestock may be assumed to be $1500 while, on account of the greater age of the alfalfa, $1000 may again be assumed from that source. Assuming the running expenses to have increased to $1000, the family expenses to $700, the total outlay will be $2000, leaving $500 with which to buy five additional cows.

Fourth Year.—The returns from alfalfa may be reduced this year to $800, while the other returns may be increased to $2000, making a total of $2800. Allowing for increase in running expenses the yearly outlay may be stated as follows:

Running expenses	$1,200.00
Family expenses	700.00
Interest	300.00
Total	$2,200.00

The balance would thus be $600, with which to buy five cows and a bull.

Fifth Year.—The returns from alfalfa may be reduced to $600, while the other returns may be increased to $2500, making a total of $3100. Allowing again for an increase in running expenses, the following may result:

Running expenses	$1,400.00
Family expenses	700.00
Interest	300.00
Total	$2,400.00

The balance will thus be $700, with which seven cows may be purchased.

Sixth Year.—Assuming a reduction of alfalfa to $300 and increase in milk and meat to $3300, the income the sixth year would be $3600. The outlay may be assumed as follows:

Running expenses	$1,600.00
Family expenses	700.00
Interest	300.00
Total	$2,600.00

This leaves a balance of $1000, with which eight cows and a bull may be purchased.

Seventh Year.—There will now be on hand forty cows, which will stock the sixty acres fully, so that the only return will be from the sale of butter fat and live stock. During the seventh year, under this plan, the owner should receive an income of $4000 and may estimate his running expenses at $2000, leaving $2000 to be divided among living expenses, interest, and reduction of debt. Assuming living expenses to have been $700, there would be left $1300 for interest and reduction of debt. At the end of the seventh year, therefore, this man's account would stand as follows:

Property, worth	$16,000.00	
Cash on hand	1,300.00	
		$17,300.00
Original investment	$5,000.00	
Debt	5,000.00	
Interest due	300.00	
		10,300.00
Balance		$7,000.00

The net anual gain, therefore, over living expenses has been $1000. Most farming operations are not so simple as this illustration, because most farming is, as it should be, more diversified. Neither does this illustration provided for sickness, lack of water, or other accidents.

Further, it assumes land well adapted to alfalfa and suitably located with reference to a creamery. On the other hand, the increase through the saving of the heifer calves has been ignored in order to balance possible loss of cows. This estimate also assumes that the owner hires all labor except, of course, his own. If he has grown or growing children, part of the running expenses here estimated may be kept within the family.

The objection may be raised to this illustration that good undeveloped alfalfa land with water rights cannot be purchased for $100 per acre. The reply is that if a greater price is paid for the land, either one must take more time to arrive at the result here indicated, or one must estimate a greater annual return. It is believed that greater annual returns would not be a safe guide for a new settler, although greater returns are often obtained. Another objection to this plan, and a legitimate one in many instances, is that usually a mortgage for $5000 cannot run without some payment other than interest. The plan is feasible only where some large interest is subdividing land and is willing to make this concession. Otherwise, one must take more time to pay off the debt, or have more capital at the beginning.*

It has been previously pointed out that in certain sections of California a one family dairy farm is about thirty acres. Possibly the larger number of dairy farms do not exceed forty acres. A person with only $5000 might, therefore, find it desirable to buy a tract of thirty or forty acres. After having developed this area, he may add to it or he may dispose of it and buy a larger tract.

It cannot be too strongly emphasized that the plan here outlined, or any similar farming enterprise, can be successfully executed only by a person who has a knowledge of the business. Persons with no knowledge of farming or the special business of dairying will only in rare instances succeed, and then only because they feel a call for the life which it entails.

The above discussion was submitted to Gordon H. True, Professor of Animal Husbandry, who commented upon it as follows:

> "I am not familiar with the prices of land that is being offered for sale in the state, but knowing that practically all the land in this vicinity is held at $300 per acre without water rights, one is led to wonder where land may be purchased for $100 per acre with water rights. . . .†
>
> "It seems to me that your estimate of $1000 for teams, machinery and tools is rather low. I believe that such horses as one should have for this work

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* In Europe, land mortgages under the rural credit system generally run from thirty to sixty years. It seems to be the consensus of opinion that if a rural credit system were established in the United States, land mortgages should be permitted to run from fifteen to twenty years.

† For further discussion of land values see page 43.

would cost at least $200 per head. It also seems that an allowance of $500 for living expenses for family is low. . . . Neither can I see where the $300 cash income could be expected the first year. It seems to me that one man working alone would be doing exceedingly well to get anything like fifteen acres of alfalfa during the first year and that from this he could hardly expect to grow enough to furnish the income that you suggest.

"Speaking in a general way with reference to the amounts allowed for the purchase of cows and bulls, it seems to me that you are not allowing enough for the character of animals that would be expected to produce the returns on which you count. Grade Holsteins have been sold in this state for over $100 per head, and dairymen find it exceedingly difficult to secure good dairy cows at any price at the present time. While I have sold registered bulls at the price your beginner could afford to pay, and have seen others offered for sale, the buyer would need some good advice in order to be able to make such purchases by mail, and he could not afford to travel in search of stock.

"The returns that you have estimated, assume, it seems to me, a character of land that may properly be called 'Alfalfa land,' much better in character than much of that offered by dealers as suitable for growing this crop."

THE RENTER AND HIS OPPORTUNITIES*

Various systems of renting land are in vogue in this state. One thing must be kept in mind, namely, that a stranger finds it difficult to secure a desirable piece of property at anywhere near a reasonable rental. Most of the tenants in California are men who have either worked for the landowner and have afterwards assumed charge of his property for him, or have successfully worked land in the immediate neighborhood. The land owner is thus well acquainted with the tenant. In the irrigated section of the state it is not uncommon for a young man who shows himself especially industrious in caring for dairy stock to be offered a proposition by the owner, who in the hot summer months may determine that he can leave his ranch in the hands of the hired man by making him a share participator, turning over his entire ranch equipment, livestock, etc. The man may agree to pay a cash rental of so much per acre and to deliver to the owner at the expiration of his lease as many cattle as are received and one-half of all the offspring. He also agrees to pay the water rentals and to keep the place in good condition. Sometimes this rental is put aside and a man will agree to rent his place with stock on condition that the renter deliver to him one-half of the monthly cream check and one-half of the sale of all farm products and one-half of the offspring that remain on the place over and above the number of animals that were there when the man took charge.

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* By DAVID N. MORGAN, Assistant to the Director.

In the irrigated section where grain is raised, it is customary for the owner of the land to pay all water rentals and furnish the seed; the renter furnishes the livestock and puts in the grain at his own expense. They share the cost of harvesting and divide the produce equally. In orchards, it is a little different, the owner usually requiring that the lessee shall pay the expenses of cultivating and handling the crop, and delivering to the owner a percentage of the gross returns.

For the purpose of this discussion, assume that a man has moved into a dairy region with his family and has worked for a leading dairyman in that section. The leading dairyman discovers in this man unusual ability. He has a dairy of thirty cows and all the necessary implements and live stock for carrying on his business. He agrees to pay for the water that is used and also to pay the taxes, insurance, etc. The renter agrees to take care of the stock and furnish at the end of his period one-half of all stock that has been raised on the farm; also to leave on the place as much hay as there was when he went there, and to keep everything in good shape. As he has a family of several children, it is possible for him to conduct this ranch without hiring additional help. He therefore agrees to pay one-half of his monthly cream check and one-half received from the sale of all produce.

In addition to the dairy cattle on this farm there are also ten yearling heifers, four mares and six brood sows. The place is leased on June 1st. Thirty cows produce twenty-five pounds of butter fat daily, and at $0.25 per pound, the prevailing price during the month of June, the dairy will produce $187.50 for the month. Six skim milk hogs are sold for $72. The gross income then is $259.50. One-half to the owner leaves $129.75 for the lessee's income. Of this sum $45 was paid to a hired man who worked in the hay field. The family expenses were $50, leaving a balance of $30.

Feed conditions in the irrigated valleys make it possible for cows to freshen in early fall. This is desirable owing to increased prices. Cooler weather also makes dairying easier.

In July, August, and September the butter fat averaged $0.30 per pound, or $37.50 per month more than in June. The expenses being the same, the net profit was $48 for each of these three months. The hired man was allowed to go at the end of the haying season, October 1st. During October, November, and December, there was produced a cream check of $300 per month. As the family did all the work and assuming that their expenses had been about the same, there should be in the bank to the credit of the family on January 1, about $500, and at the end of the first year $1000. In addition to this the renter should have young stock to the amount of several hundred dollars on the ranch. At this rate in three years time the lessee is in a position to purchase all livestock and enter into a lease with the owner on terms of cash rental for the land and improvements, or he may buy some livestock elsewhere and with his share of the offspring rent a different place for which he pays a cash rental. Assuming that his gross income for the next three years would average $3000 per year and living expenses will take one-half the sum, the renter should have $4000 in cash and about $5000 worth of livestock and implements. He will then be in a position to buy a place of his own, paying half of the purchase price in cash and borrowing some additional capital on his livestock if necessary to make additional improvements. In four years more the man should have a comfortable home entirely paid for, a steady income, and be worth more than $15,000. In twelve years from the date of first locating in the favored dairy region, this man with the help of his growing family, has secured a competence and provided for the future. It is recognized that only men of more than ordinary perseverance are willing to make necessary sacrifices the first few years in familiarizing themselves with the region and methods used; also, that only an extraordinary man would attract the attention of a rancher unless he had been actually employed by him. Owners are averse to renting on such a basis to men they do not know favorably, for it would be too easy for them to lose heavily by mismanagement, and the average renter when he starts work does not possess much of value that can be held for security guaranteeing fulfillment of his part of the lease. However, it is not impossible for a man with more than the average ability, with a family, and with good health to do just as well as the renter discussed above.

CALIFORNIA CROPS

Members of the staff have prepared articles on the growing of certain standard crops in California. The plan has been to give that information which an eastern man with an actual knowledge of farming or fruit raising would most need to know. It is not intended as full information for a beginner. The following are points which each specialist had in mind while preparing the articles:

Discuss the industry as it exists—not as it did exist in the past, nor as it may exist in the future. Assume the settler has decided to grow the crop.

Say nothing of its importance except as an aid to finding proper location. State main objections to the crop as an industry.

Regions.—Give important centers of industry. Name town or towns it would be wise to visit in order to see the industry to best advantage. Give best climatic and soil conditions, especially things to avoid.

Methods.—State the methods that are actually in vogue, not merely methods that are recommended as ideal or desirable.

Call particular attention to methods with which strangers will most likely be unfamiliar.

Tell things to be guarded against.

Size of farms growing this crop.

Mention location of lands yet available for development.

Give ordinary commercial value of developed and undeveloped lands.

State methods of renting and give rental values.

Give kinds of labor and ruling prices.

Discuss methods of marketing.

No attempt has been made to include all the crops grown in California, but only a few of those most typical and representative of the agriculture of the state. Even according to this rule there are important omissions.

The list of crops discussed follows:

Alfalfa
Almonds
Barley
Beans
Citrus Fruits
Cotton
Figs
Grapes
Olives
Onions
Pears
Prunes
Potatoes
Semi-tropical Fruits
Sugar Beets
Walnuts

THE ALMOND

By R. H. Taylor, Instructor in Pomology

The almond can be grown only in limited areas, owing to its susceptibility to frost. This is not due, as often supposed, to any greater tenderness of the blossoms or young fruit, but to the fact that this tree is the earliest of all our tree fruits to bloom in the spring, thus rendering it liable to more severe frosts than fruits which bloom later.

The localities where the almond succeeds best are where there are no late spring frosts. Low lands should be avoided because of the settling of cold air in these spots, causing later and more severe frosts than in adjacent higher land. Rolling hills just back from the lower levels of our large interior valleys and the alluvial fans projecting out from the hills, furnish the larger portions of our safe almond localities. Where large streams have built up the general level along their banks far out into the main valleys, freedom from frosts is again marked.

The soil best suited to the almond is a deep loam which is free from hardpan, or gravelly substrata, and at all times well drained. The almond will not endure standing water around its roots for any length of time and especially during its long growing season. The lighter soils, therefore, are the ones which should be sought. Too light a soil is equally undesirable, in being unable to retain a sufficiently uniform moisture content.

Large quantities of almonds are at present grown along the banks of Putah Creek between Davis and Winters, along Cache Creek near Esparto, and on higher up the creek throughout the length of Capay Valley, along the rolling hills around Arbuckle, on the higher lands around Chico and Gridley, on the higher lands near the foot of the Marysville Buttes, in Contra Costa County (notably at Oakley), near Oakdale, near Acampo and Lodi, and in Southern California, notably at Banning, in Riverside County.

In the most favorable soils the almond is grown on almond root. Where the soil is inclined to be more gravelly and too well drained, and irrigation water is available, the peach root is used, while in heavy soils the Myrobalan root is used. Plantings on heavy soils do not ordinarily do well and should be very sparingly practiced, and then only when one understands just what he is doing.

After planting, the tree is generally headed to eighteen inches from the ground and a head formed. In subsequent years the trees are headed back from two to four years, and after that pruning is limited to thinning out too thick and interfering branches and dead wood. Keep the center of the tree rather open to encourage fruiting well down to the center of tree.

The trees should come into profitable bearing about the sixth year.

Harvesting, which commences a little before the middle of August, and continues in the various varieties until the middle of September, is done by knocking with long poles on to sheets spread under the trees. From here the nuts go to the huller, where they are separated from the hulls, then dried, bleached and sacked for shipment.

Late ripening varieties will not do in regions subject to early rains or where fogs are prevalent, as the shells are darkened too much.

The most important pest of the almond is the Red Spider.

Root knot and oak fungus (*Armillaria*) must also be guarded against when the trees are being planted.

The almond is grown on farms ranging from an acre or two up to one hundred or more acres. The average orchard is not over thirty acres.

In all of the above mentioned districts there are lands still available for development, but care must be exercised to determine whether or not such delayed development is due to frequent late spring frosts occurring there.

Good unimproved almond land may be purchased at from $185 to $350 per acre. Land with trees in bearing runs from $250 to $600 per acre and over.

Although there are independent buyers, the marketing of this crop is done largely through the California Almond Growers' Exchange, with offices in Sacramento.

ALFALFA CULTURE

By B. A. Madson, Assistant Professor of Agronomy

The climatic and soil conditions of the state are eminently suited to the growth of alfalfa. While these two factors have doubtless played an important part in centralizing the industry in certain sections of the state, water has in all probability been the controlling factor. Modesto, Turlock, Merced, and Fresno are especially noted as centers of alfalfa production, and here also we find irrigation highly developed. Within the past few years the Imperial Valley with its abundant water supply has become an extensive producer of alfalfa.

With regard to soil requirements, while alfalfa is not fastidious, there are certain conditions which are unfavorable to its growth. It thrives best on a deep, fertile, well-drained loam, of uniform character and of high lime content. Soils which possess an impervious stratum or hardpan near the surface or which have a high water table, should be avoided. The alfalfa plant is a gross feeder, possessing an extensive root system, and any soil condition which interferes with its free development will materially check its growth. Acidity or excessive alkalinity are of course always objectionable. The former condition occurs only to a limited extent in this state, but the latter is quite prevalent and is frequently associated with hardpan.

While it is true that in a few sections alfalfa is successfully grown with natural sub-irrigation, the highest degree of perfection is seldom attained unless the farmer has at his command an adequate supply of irrigation water, obtained either from a ditch or from wells.

The first step in the preparation of the field for alfalfa is to level and check for irrigation. This work is usually done by contract, either in the summer or early fall, while the soil is dry. The average contract price for grading and checking land is about $18 per acre. The system of checks to be used, must be governed by the character of the soil, the contour of the field and the volume of water available. If water can be obtained in the late summer or early in the fall, it is a common practice to irrigate the land, prepare the seed bed, with a disk and harrow as soon as possible after irrigation, and then seed the alfalfa. If the crop can be put in by the middle of September, it will usually attain sufficient growth before winter to withstand the frosts. More often, however, after the land is checked it is allowed to lie idle until spring, when the seed bed is prepared, and the alfalfa seeded at the rate of twenty pounds per acre.

Upon a well established alfalfa field, five to seven cuttings are obtained per season. The crop is cut when one-tenth in bloom or when new shoots appear at the crown.

The alfalfa ranches of California are much smaller than the grain ranches, varying in size from forty to fifty acres to several hundred acres. In order to handle the crop successfully it requires about two men and two teams to every forty acres, although upon the larger fields, with the use of larger implements this proportion may be somewhat reduced.

Under normal conditions four to six tons of hay per acre may be considered a fair yield, though where conditions are especially favorable and when the best culture methods are practiced, eight to ten tons are not impossible.

The cost of preparing the seedbed and seeding the crop, together with the cost of seed, is about $7.50 per acre.

It is only in case of large tracts, that alfalfa culture is carried on as an independent enterprise. The smaller tracts more often constitute a part of some more diversified type of farming. In either case, alfalfa production is both a desirable and profitable business, giving good returns and providing employment of men and teams during a large portion of the year. On the other hand, the fact that it remains permanent for so long a period of time, eliminates the possibility of much crop rotation, a condition which is never conducive to the best type of agriculture.

The rental price of alfalfa land varies from $12 to $15 per acre, depending upon the locality. In a few cases where intensive dairying is practiced and the alfalfa hay is fed on the ranch, $20 an acre is secured. Renting on shares is not as common as with grain land, though it is practiced to some extent, the owner receiving one-third of the crop and in nearly all cases supplying the water.

Developed alfalfa land favorably located and in good condition commands a price of from $250 to $300 or more per acre. There is, however, still considerable undeveloped land in many of the alfalfa growing sections of the state, which can be purchased for $150 to $200. Higher prices should not be paid unless it has been proved that the conditions are especially well adapted to the production of the crop. There are suitable areas for growing alfalfa, which will in all probability be eventually used for that purpose, though not at present considered within the alfalfa growing sections, which can be purchased for $100 per acre or less.

BARLEY PRODUCTION

By B. A. Madson, Assistant Professor of Agronomy

Barley is grown quite generally throughout California, but its production, like the production of other cereal crops, is confined to the sections of the state where dry-farming must be practiced. It is only in rare instances that the crop is irrigated, because where irrigation can be developed the land becomes too valuable to be used for barley.

The ability of barley to grow under conditions of limited rainfall has doubtless played an important part in concentrating the industry in those sections of the state where the annual precipitation is low. Thus we find the greatest production in the San Joaquin Valley, especially in the vicinity of

Stockton, Merced, and Madera. It is also grown extensively near Colusa in the Sacramento Valley and near Gonzales, Monterey County, on the coast.

Barley seems to thrive better in a warm dry climate than in a cool, moist climate, and fortunately the former condition prevails quite generally in this state. With regard to soil requirements, barley is perhaps more exacting than any other crop. Briefly stated, it seems to thrive best on a rich, fertile loam, well drained and rather light in character. Soils that are low in fertility, extremely light or extremely heavy, or soils that are cold and damp for a long period during the winter should be avoided for this crop. The barley plant has a rather tender root system and any adverse soil condition is apt to produce a marked injurious effect.

The dominant feature which characterizes barley culture in this state at the present time is mass production rather than maximum production per unit area. The farms upon which grain plays an important part are usually large, varying from two hundred acres to one or two thousand acres or more in size. In order to handle such immense areas the method and implements used must necessarily be such as will enable the farmer to cover the most ground in the shortest possible time.

In the fall or early winter as soon as sufficient rain has fallen to moisten the soil, the fields are plowed to a depth of three or four inches, using large gang plows in order to hasten the work. On the smaller farms mules are used as motive power, while on the larger ranches tractors are more common. After the field has been plowed it is disked, seeded broadcast, and harrowed, which completes the operation of putting in the crop. Upon the larger ranches, with the use of a tractor and the proper combination of machinery, the work of plowing, disking, seeding, and harrowing is often done at a single operation, which greatly reduces the cost per unit area. Four or five men with a single outfit can handle from three to five hundred acres or more, depending upon the season.

The usual practice is to harvest the crop with a combined harvester, which cuts, threshes, and sacks the grain, ready for market, at a single operation. Five or six men are required to run the outfit, and can cover from twenty-five to forty acres per day. The combined harvester has greatly reduced the cost of handling the grain crop, but it is very wasteful of grain and its continued use renders the fields extremely foul.

In a few instances on the smaller farms summer fallowing for barley is sometimes practiced. The fields are plowed in the fall and allowed to lie idle for a year, with an occasional harrowing to prevent the growth of weeds and also to prevent the loss of moisture by evaporation.

Under conditions of continuous culture, fifteen sacks is considered a fair yield. In rare cases twenty sacks are obtained, but more often the farmer is content with ten or twelve. In the fallow land thirty sacks per acre is considered good.

The cost of plowing, disking, seeding, and harrowing, together with the cost of the seed, is about $5 per acre. The cost of harvesting a fifteen-sack crop of barley, including sacks, is about $3.50 per acre. To this must be added an additional cost of 75 cents for marketing, making the total cost of producing the crop $9.25 per acre. The average price of barley is about $1.10 per hundred, giving a gross return of $16.50. After subtracting the cost of production there remains a net return of $7.25, which must cover taxes, depreciation on equipment, and interest on investment. The cost of producing the thirty-sack crop on the fallowed land is about three-fourths the cost of producing two fifteen-sack crops, so that the net returns will be somewhat greater.

With methods of handling at present in vogue, barley farming, in order to be profitable must be conducted on relatively low-priced land. Profitable returns cannot be obtained on land which exceeds $75 to $85 per acre in value except when grown in rotation with other crops.

The usual basis for renting grain lands is on shares, the owner requiring one-fourth to one-third of the crop. This means that normally eight to ten sacks must cover the cost of production and besides leave something to the farmer for his trouble.

Grain farming has some advantages and some distinct disadvantages. In the first place, it is a type of farming which requires a minimum of labor and only a comparatively small outlay for equipment; the only time help is required is during seeding and harvesting. The labor available is largely of the transient type, which can be obtained for from $2.25 to $3 per day. On the other hand, with grain as the dominant feature, the equipment must necessarily lie idle the greater portion of the year, so that its total cost must be charged against the grain crop. Then, too, constant cropping to grain is not a commendable practice, inasmuch as the continuous shallow cultivation greatly impairs the physical condition of the soil, so that the farmer must continually put forth greater effort to maintain his yields. It is the type of farming, however, which is, as a rule, practiced on new land, as it requires but little capital at the start.

There is still considerable undeveloped land suitable for this type of farming available in the foothill regions of the Sacramento and the San Joaquin valleys, as well as in some of the smaller and more isolated valleys of the state, which can be purchased for $40 to $60 per acre. In the developed sections, on the other hand, there is but little land that can be purchased for less than $100 an acre.

BEAN CULTURE

By John W. Gilmore, Professor of Agronomy

Bean culture in California may be considered under two heads, namely, field bean culture and Lima bean culture. While the soils and culture methods for these two types of beans are similar, they differ materially in respect to their requirements for temperature and moisture, including humidity.

Lima Beans.—Mainly because of this difference the Lima bean is most extensively produced in the counties along the coast, including San Diego, Orange, Los Angeles, Ventura, Santa Barbara, and San Luis Obispo. In these counties the valley soils are deep and strong, and the peculiar requisite moisture conditions are afforded by frequent fogs from the ocean. The summer temperature in these bean sections is tempered especially in respect to its uniformity by ocean winds. This industry may be most profitably investigated in the vicinity of Ventura, San Luis Obispo, Santa Barbara, Los Angeles, and Oxnard. In California the climatic conditions are more important as a limiting factor in the production of Lima beans than the soil, except in cases where the soil is unsuitable because of an alkali or an acid condition.

Culture Methods.—The bean is a relatively deep rooted plant, hence deep preparation of the soil is an important factor in the production of the crop. The land is plowed from six to eight or more inches deep as early in the autumn as is rendered possible by the rains. The land is left with rough, untreated surface during the winter months in order to impound as much of the winter rains as possible. During February and March, when most of the rains are over, the surface is worked a number of times to smooth it down, to kill early germinating weeds and to prepare the surface for the conservation of the stored moisture and for the planting of the seed. The work that has been expended upon the land up to this time comprises the major portion of the culture that the crop will receive, and this is very important, for thorough preparation in bean culture is more than half the labor insuring a crop. In Lima bean culture this thorough preparation is all the more necessary because little or no rain falls in the regions mentioned between the planting and the harvesting of the crop.

Planting is usually best accomplished during the earlier days of May. By this time the soil has become warm and the free water has distributed itself through the soil. If beans are planted in cold, wet soil they will rot, or at best the plants will be non-uniform and retarded in their growth. From forty to sixty pounds of seed are used per acre, according to the size (the variety) of the seed and the physical condition and the strength of the soil. With optimum physical condition and moisture content, less seed is required, for the fewer plants will cover the ground better and yield more. The rows are arranged from thirty to thirty-six inches apart and the beans are planted and thinned so as to stand eight to twelve inches apart in the row. On the stronger and moister soils the wider distances are given. Two inches is about the right depth of planting.

During the growing season the crop is given several shallow cultivations until the vines cover the ground, and during this period also one or two irrigations are given, unless through excellent preparation of the soil or abundant winter rains the growing crop does not need the moisture. On account of the absence of rainfall during the growing season Lima beans in California do not have to be staked.

Lima beans ripen from August 25th to September 25th. When the pods have matured and begun to turn yellow, the vines are cut just beneath the surface of the soil and are afterwards thrown into small piles for ripening and curing. In cutting, from five to six acres per day is considered a day's work, while in piling a man will accomplish from three to four acres.

Threshing is usually accomplished by itinerant companies putting up from 1000 to 2500 sacks per day. The charge is from twenty to thirty-five cents per sack, according to location or accessibility.

The yield of Lima beans may range from ten to twenty-five sacks (80 lbs. each) per acre. The average is about fourteen sacks. The farmer's selling price ranges from four to six cents per pound. The cost of production ranges from eighteen to twenty-five dollars per acre. On the basis of net returns Lima bean land is worth from $250 to $500 per acre.

This crop is produced on farms of all sizes, from small areas of five and ten acres to large estates operated by corporations. The implements of culture and production are not expensive. When land is rented the tenant usually furnishes everything and retains two-thirds of the crop.

Field Beans.—What has been said regarding the soil requirements and culture methods of Lima beans applies also to field beans. The principal regions for the culture of these beans, however, lie within the Sacramento and upper San Joaquin valleys, principally in the counties of San Joaquin, Sacramento, Sutter, Contra Costa, Solano, Yolo, and Colusa. Some black eye and pink beans are grown in Stanislaus and Merced counties, but in general the summers in these counties are too warm for most of the varieties.

In the counties mentioned the rainfall and temperature vary more widely than in the Lima bean regions, consequently one must exercise a stricter choice of localities for successful bean growing. The heavy adobe and the light sandy soils should be avoided, not alone because of their crop producing power, but also because of their water-holding capacity. The heavy soils do not respond to the operations of tillage in the proper manner, often being too lumpy and hard, and the lighter soils are not sufficiently retentive of moisture.

A satisfactory yield of field beans is about 1400 pounds per acre, though on account of climate and soils the yield varies greatly, 2500 pounds per acre being frequently produced. The farm price varies with the variety from three cents to eight cents per pound.

The cost of production of field beans varies more widely than for Lima beans, mainly owing to variation in soil conditions. The most usual figure is between $15 and $18 per acre.

CITRICULTURE

By J. Eliot Coit, Professor of Citriculture

There are about 180,000 acres planted to citrus fruits in California, the proportion of lemons to oranges being as 1 to 5. There are about eight thousand citrus growers, the average holding being therefore about twenty acres. The annual shipments are now about 40,000 cars or 14,500,000 boxes, being approximately one-sixth of the world's supply.

Citrus fruits are grown in favorable localities from San Diego County to Shasta County. The localities are in the order of present importance: (1) the area enclosed in and adjacent to a triangle drawn through Pasadena, Redlands, and Santa Ana; (2) the eastern foothills of Tulare County; (3) Ventura and Santa Barbara counties; (4) San Diego County; (5) Butte County. There are a great many smaller areas scattered through the state which are well suited to citrus fruits. The industry is older in Southern California and there the lands and water have been further developed and prices of land and water are much higher than in the central and northern parts of the state. The cost of land varies from $150 to $500 an acre and water rights from $75 to $300 or more. It costs to establish an orchard and care for it through the first five years from $800 to $1200 per acre in Southern California and from $500 to $900 per acre in other parts of the state.

It is not the custom to rent citrus properties in California. The labor in California citrus groves is done principally by Americans, although a good many Mexicans, Italians, and Orientals are employed. Foremen receive from $50 to $100 per month, teamsters from $50 to $65, irrigators from $2.00 to $2.50 per day, pruners from $2.00 to $3.50 per day, picking foremen from $2.25 to

$3.50, pickers from $2 to $2.50, and fumigators from 25 to 50 cents per hour. Ordinary labor is paid $1.50 to $2 per day.

Orange trees which have been properly grown should yield 350 to 400 packed boxes or a car per acre after twelve years old. Lemons will yield about one-third to one-half more tonnage per acre than oranges.

About 60 per cent of the fruit is sold through a very well organized co-operative selling agency known as the California Fruit Growers' Exchange. The grower buys stock in proportion to his acreage in a local packing-house which is owned and operated by an association of growers. Several associations together form a district exchange which orders cars, ships the fruit, and distributes the returns. All of the district exchanges belong to the central exchange which furnishes facilities for marketing the fruit in the shape of bonded agents working under salary in the principal markets. The central exchange also furnishes daily market reports and other information. Grower-members are prohibited from selling and delivering fruit outside of the association. Growers may withdraw from the association at the end of any year.

There are about forty co-operative marketing associations outside of the Exchange and a number of independent grower-shippers. Very little fruit is shipped on consignment.

Some persons have made fortunes in citrus fruit, while many others have lost money. Others would have lost money had it not been for the timely advance in the value of the land for residence or other purposes.

Any person, however, with sufficient capital, a reasonable knowledge of horticultural operations, and ordinarily good business judgment, who is industrious and persevering, may expect to make a good profit by raising citrus fruits, provided he or she pays attention to the following points:

1. Select a location in a proved citrus district reasonably free from frosts and winds and within hauling distance of a packing-house.

2. Select a deep soil easy to work, fertile, well drained, and drive a good bargain for it.

3. Be sure of an ample supply of good water to which the land has an inalienable right. For full bearing trees near the coast on a retentive soil about 1¼ miners' inches of water is needed for ten acres. The same trees in interior valleys and especially on gravelly soils need not less than three miners' inches to ten acres. When buying a young grove bear in mind that only a small amount of water is needed for small trees and that some people develop groves with insufficient water rights with the intention of selling to an inexperienced person at the critical time. Beware of a citrus development based on surplus water.

4. Secure good strong trees free from scale which have been propagated from carefully selected buds of standard varieties. The standard varieties in California are few in number. They are: Navel and Valencia oranges, Eureka and Lisbon lemons, Marsh seedless pomelo, and Dancy tangerine.

5. Plant the trees properly, using great care not to let the sun strike the bare roots. Inexperienced planters should purchase balled trees, as there is less danger of losing them during transplantation.

6. Care for the trees personally and conscientiously in regard to cultivation, irrigation, fertilization, and pruning.

7. Prevent scale insects and diseases from gaining a foothold. Remember that the average cost of fumigation is $30 per acre every alternate year, and

this is 6 per cent on $500, consequently in a scale-infested locality land is worth less for citrus production, other things being equal.

8. Join a local marketing association and co-operate with the neighbors in frost fighting, insect and disease control, and in other ways for the general good of the neighborhood.

9. Write freely to the College of Agriculture for advice and enroll for the Correspondence Course on Citrus Fruits.

COTTON RAISING

By W. E. PACKARD, Agronomist in charge of Imperial Valley Experiment Farm

Cotton raising is at present confined to Imperial County and a small acreage in the Palo Verde Valley of Riverside County. El Centro and Calexico are the chief cotton centers. Cotton can be raised in any of the interior valleys of the state where irrigation water is to be had and where there is assurance of freedom from cold coast fogs, but it should not be planted on a commercial scale unless cheap experienced labor is available and ginning facilities are secured.

Three general types of cotton are grown—the short staple, medium long staple, and long staple. It is highly desirable that one type be selected in any one section, as promiscuous plantings cause deterioration by cross pollination. The short staple cotton is the most commonly planted, as the market is established and less care is required in growing. The short staple has an average length of one inch, which is one-eighth inch longer than the average in the South, and yields from three-fourths of a bale to two bales per acre, with a ginning percentage of 33 to 34 per cent. The price varies from 8 to 14 cents per pound, with an average of 11 cents.

The Durango cotton, a medium long staple variety coming from Mexico, has an average length of one and three-sixteenths inches. It yields from one-half to two bales per acre, a bale to the acre being an average. The ginning percentage of this variety is low, averaging from 29 to 31 per cent. The price is from 2 to 4 cents per pound higher than the short staple.

The long staple or Egyptian cotton has given good results, but its cultivation has been discontinued for the present on account of unsatisfactory labor and market conditions. The Sea Island cotton has not proved a success.

In securing land for cotton planting, hard stiff clays or land containing an excess of alkali should be avoided, although cotton will stand more alkali than any of the common field crops. Medium heavy or medium light soils give the best results. Old alfalfa land is very well adapted to cotton.

Cotton is planted any time after the danger of frost is over to the first of June, April being the best month. The usual practice is to flood the field thoroughly early in the spring. The land is then disked to kill the weed growth and later furrowed from 3 feet 6 inches to 3 feet 10 inches apart with a lister. After furrowing, the land is irrigated and the seed drilled in from one and a half to two inches deep on the top of the ridges. The seed is usually irrigated up. The land is sometimes harrowed after seeding with very good results, especially where the soil tends to crack or crust. Plowing is of course very beneficial.

Cotton is sometimes planted flat and where the soil is soft the results are good. The land is flooded, then disked, harrowed and seeded as soon after irrigation as possible. The objection to this plan is that the seed is often planted where there is insufficient moisture or where the soil is not well compacted about the seed. This system is good for alkali land where water table does not exist, as the flooding tends to wash the salts to the sub-stratum and the mulch prevents excessive evaporation and consequent surface accumulation of salts.

Volunteering cotton from year to year has proved to be a profitable practice and is being followed quite extensively. If the rows are ridged up well in the last cultivation, the earth about the stem prevents the freezing of the buds and a good stand is secured without reseeding, while if not ridged many of the stalks are killed.

The main aim in the irrigation of cotton is to maintain as uniform a moisture condition as possible. Too much or too little moisture hurts the plants and any sudden change from a dry to a wet soil invariably causes a great loss of squares. The outer growing tips are good indicators of the needs of the plants. Soils vary a good deal in their water-holding capacity and each farmer should know his soil type and irrigate accordingly.

Cultivation is done with an ordinary two horse corn and cotton cultivator and is continued as long as possible. Very little hand work is done, except at thinning time, when the plants are hoed out to a distance of about eighteen inches. Thinning is done when the plants are from five to ten inches high.

The labor problem is the main obstacle to cotton raising in California. It is hard to procure experienced pickers. Most of the picking is done by whites and negroes, although Mexicans and Hindus do good work. Picking costs from $0.75 to $1.25 per hundred pounds seed cotton.

Most of the cotton goes to the eastern mills, practically all of the Durango going to the American Thread Company of New York. Cotton is sold at about forty points or two dollars per bale off from the New York quotations. Most of the cotton seed is sold to the cotton seed oil mills at $15 per ton. The oil produced is shipped out and the cotton seed meal and hulls are used locally for feed. About one-third of the cotton is marketed through the Cotton Growers' Exchange, the rest going to individual buyers.

Land suitable for cotton can be bought for from $100 to $175 per acre fully water stocked, or can be rented for from $10 to $15 per acre. There are opportunities for getting cheap land, but when levelled and water stocked the cost will approximate $100.

Cotton is often grown on shares. The land owner usually furnishes all horses and tools and pays the taxes and all water charges, the last named usually amounting to about $3 per acre. The renter furnishes all labor and receives from one-half to three-fifths of the crop at the gin, each paying half the ginning expenses, which amount to $4.50 per bale. The seed is divided equally. If the renter furnishes horses and tools he gets three-fourths of the crop.

FIG CULTURE

By J. Eliot Coit, Professor of Citriculture

There were in 1910, 5380 acres planted to figs in California, and there has been much additional planting since that time. About one-half the fig trees of the state are grown in Fresno County. The average consumption of dried figs in the United States for the last ten years was 12,100 tons per year. Only one-fourth this amount is produced in California, about one million dollars worth being imported from Turkey each year.

While in many parts of California from Shasta to Imperial County, figs grow and produce fruit suitable for eating fresh, the production of dried figs on a commercial scale is limited largely to the San Joaquin Valley, where the climatic conditions permit out-door drying and curing.

In sections where the natural rainfall is sufficient for figs to be grown without irrigation, good land may be had at from $75 to $125 an acre. Where irrigation is necessary the cost of land with rights to sufficient water for an established irrigation system will vary from $150 to $200 an acre. In much of the available fig land the water table is near the surface. For best results the water table should not be nearer than ten feet. When nearer than this the value of the land should be discounted and when nearer than four feet figs should not be planted.

Fig trees come into bearing in three to five years, and should be in full bearing at twelve years of age. Where irrigation is not practiced the cost of bringing an orchard into bearing will vary from $40 to $70 an acre. Where irrigated the cost will run from $100 to $250.

Average Cost of Bringing Fig Orchard to Bearing

Fifty trees at 20 cents	$10.00
Plowing	4.00
Grading	10.00
Irrigating system	20.00
Planting	3.00
Cultivating, irrigating, cost of pumped water	200.00
Cost of land (from $150 to $250 per acre)	200.00
Total investment at beginning of sixth year	$447.00

This figure may be reduced by raising interculture crops between the trees. The cost of operating a bearing fig orchard, including harvesting, taxes, interest, etc., will vary from $75 to $100 per acre per year. It is not the custom to rent fig properties in California.

The yields to be expected vary widely, but averaging the good and poor seasons together, they may be expected to be somewhat as follows: Mission, 2½ to 3½ tons per acre; Adriatic, 2 to 2½ tons; Smyrna, 1½ to 2 tons.

The fig grower at present is at a great disadvantage in marketing his crop. No co-operative selling organization exists, although there is a great need for one. Under present conditions the grower may receive from the packers for the Mission two cents, for Adriatic three and a half cents, and for the Smyrna five to six cents per pound on a sweat-box basis. At present the Adriatic is especially profitable when grown as a border around vineyards and along roadways. Under such conditions there is little expense and the fruit often sells on the trees for as much as $2 per tree.

The business of packing and shipping fresh figs is good, but the profit depends upon the price and the availability of pickers and transportation facilities. There is a limit to the amount of figs which may be disposed of locally in this way, the supply far exceeding the demand. In a few cases very high prices have been secured for extremely early fresh figs shipped from Coachella Valley to the New York market in crates carrying cracked ice. Good prices may be secured in California for these early figs, but the demand is limited.

Fig trees are singularly free from pests and diseases, the only trouble worth mentioning being a nematode worm, which inhabits the roots when grown on very light sandy soil.

After being once well established a fig orchard should bear well as long as properly cared for or for one hundred years.

The artificial process of caprification is necessary only with Smyrna varieties.

GRAPE GROWING

By F. T. Bioletti, Professor of Viticulture and Enology

Grapes are grown profitably in every county in California, except one or two in the extreme north and two or three in the higher mountain regions.

Varieties and Localities.—Grapes for dry wine are grown most profitably in the coast counties from Mendocino to San Diego, where the acidity of the fruit and the cool weather of the vintage are suitable; sweet wine grapes in the great interior valleys from Shasta to Kern and also in parts of the San Gabriel Valley in Southern California, where rich soil insures large crops and the climate promotes low acidity and high sugar content in the grapes.

Raisin grapes are grown principally in the San Joaquin Valley, with Fresno as the center. Here the Muscat and Sultanina develop the necessary sugar early enough to be dried in the sun while the weather is still hot and dry. Minor centers where good raisins are made occur in the central part of the Sacramento Valley and even near the coast in the extreme south, but drying the fruit is often uncertain and dipping or artificial driers must sometimes be resorted to.

The earliest shipping grapes are Sultanina and Malaga from the Coachella and Imperial valleys. The next, principally of the same varieties, come from the foothills of Tulare County and the neighborhood of Winters and Vacaville. Malaga is the principal white shipping grape and is grown most largely in the San Joaquin Valley south of Modesto. The Flame Tokay, which constitutes the main bulk shipped, is grown principally in San Joaquin County, with Lodi as a center and in Sacramento County along the American River. Farther south it fails to develop sufficient color. The next most important shipping grape is the Emperor, grown principally in Tulare and Fresno counties. The latest shipping grapes are grown in Contra Costa and Santa Cruz counties principally. In general, shipping grapes can be grown profitably only in localities where packing and transportation facilities have been established. Rich soil and abundant water are necessary.

On a twenty acre vineyard most of the work except harvesting can be done by the owner himself. Unless he has had considerable experience, it would be unwise to attempt to handle more.

In starting a vineyard great care should be used in choosing the planting stock. As a rule one year old rooted vines grown from cuttings carefully selected from healthy, profitable vines should be used. In rich, moist, sandy loam the cuttings may often be planted directly in the field with considerable saving in expense and some in time. In most of the coast regions phylloxera resistant bench grafts must be used.

The soil should be cleared, levelled where irrigation is needed, and plowed or subsoiled at least twelve inches deep before planting. Great care in training and pruning the young vines for the first three years before they come into bearing is necessary. Stakes must be used from the end of the first year until the vines can support themselves. Some varieties, such as Sultanina, require trellising. Pruning must be done by expert hands and must be adapted to the particular variety. Sulfuring once, twice, or three times during the season is needed to control the Oidium. Special methods of thinning and harvesting are needed for some table grapes.

A well-managed vineyard may yield a net profit of from $50 to $200 per acre when in full bearing. One which is neglected will often fail to pay running expenses.

Suitable land can be obtained for from $150 to $250 per acre in small tracts. The cost of planting and care of an ordinary vineyard for the first three years will be about $150. Where resistant vines are used about $40 per acre must be added to this. If the vines are to be trellised like Sultaninas from $25 to $30 per acre must be added.

The average cultural expenses of a bearing vineyard will seldom be less than $12 per acre per annum and the fixed charges for taxes, depreciation, and interest on the investment will usually exceed $20. The production of shipping grapes perhaps offers the most promising opportunity for profit, but whether the promises will be realized depends on co-operation of the growers in marketing.

ONION RAISING

By S. S. Rogers, Assistant Professor of Plant Pathology

The requirements for onions are so exacting that the novice should not undertake the production of onions on a large scale until the requirements of the crop are known and local conditions thoroughly understood There is such an enormous acreage adapted to onion growing in this state that the markets may be easily glutted. Some years the grower may realize a net profit of several hundred dollars per acre and the next season the returns may not be sufficient to meet expenses.

The largest centers for the production of onion seed are located in the Santa Clara Valley near the city of San Jose and in San Benito County near the town of Hollister. Onions for the market are produced in large quantities in the Imperial Valley and in the vicinity of the larger cities such as San Francisco, Oakland, Sacramento, Fresno, and Los Angeles. Onions will grow on a variety of soils, but the most favorable is one which holds moisture well although friable enough to be easily cultivated and to allow the proper expansion of the root. A heavy, sticky adobe or a coarse, gravelly soil should be avoided. The onion can stand without injury a much lower temperature than many other vegetables, and if given sufficient moisture it will endure the heat well. Before planting, the soil should be put into the finest condition of tilth possible and the culture throughout the entire season should be such that there will be no weed growth and a good mulch preserved. If hand implements are used the rows may be planted about twelve inches apart, while if the cultivation is to be done by horse-drawn implements the rows should be two to three feet apart. Cover the seed about one-half an inch when planting on heavy soil and about one inch when planting on light soil or late in the season. In many sections of California onions can be successfully sown during any month of the year, but the bulk of the seeding is done during the months of February to May, inclusive. Onions are propagated in California from seed planted directly in the field, by transplanting the seedlings, and from sets. The first two methods are the most common. The Red Wethersfield, Australian Brown, and Danvers Globe are the most popular varieties, although there are many others grown in this state.

When grown for pickles and green onions harvest whenever they attain the desired size. For dry onions harvesting should not be commenced until the tops of the majority of the onions have begun to turn yellow and dry. If deferred too long the onions will grow new roots, which ruins them for marketing except when consumed immediately. The crop is thrown in windrows and allowed to cure for several days and in some localities longer. When the tops have become thoroughly dried they are cut or twisted off about one-half an inch from the bulb. The latter are placed in piles, thoroughly dried and sacked. When growing onions for seed, the first season's work consists of growing the bulbs or mother onions, which are produced and harvested in the same manner as growing mature onions. In the following spring these bulbs are transplanted to the field and are allowed to go to seed. In the fall, when the seed has completely ripened it is harvested, cleaned, and stored in sacks ready for shipment.

Soil suitable for onion growing ordinarily varies from $200 to $500 per acre, including a suitable water supply. Most of the manual labor is done by Japanese, who are paid from $1.50 to $2 per day.

OLIVE CULTURE

By W. F. Oglesby, Assistant in Viticulture

Regions.—Olives may be grown in most of the foothill sections of the interior valleys as far north as Redding and in the warmer sections out on the floor of these valleys. They may, also, be grown in favored spots in all the coast valleys south of Mendocino County, although the cooler atmosphere retards somewhat the development and ripening of the fruit, and black scale is often troublesome and hard to control. It would be well for those who contemplate the planting of olive orchards to visit such places as Oroville, Fresno, San Bernardino, Los Angeles, and San Diego, as the factors in these places and the districts around them will give some idea of conditions required. If the visit be made in late summer the disadvantages of shallow, leachy, heavy, or poorly drained soils, as well as close planting, poor pruning, poor cultivation, and poor drainage, will be readily seen.

Climate.—Olive trees will grow wherever the temperature does not go below 15° F in winter, but for fruit the latest killing frost in spring should be in April and the earliest killing frost in the fall late in November. From blossoming time to frost or for at least six and one-half months the mean daily temperature should not be less than 66° F. A higher mean would be better.

Soil.—A deep, rich, well-drained, sandy loam with a high lime content and enough *ferric oxide* to give it a good red color is the ideal soil for olives. They will do fairly well, however, on any well drained soil. Very heavy or poorly drained soils, as well as those too coarse or gravelly to hold moisture, should be avoided.

Irrigation.—No olive orchard should be planted without making provision for irrigation. The trees may do well and an occasional crop may be obtained, but an unirrigated olive orchard will prove of little commercial value. An olive orchard should be irrigated from three to twelve times per year, according to the character and depth of the soil. An equivalent of one miner's inch continuous flow during the growing season should be provided for each five acres of orchard as a minimum.

Cultivation.—Olive orchards should be plowed deeply at least once a year and thoroughly cultivated after each irrigation.

Pruning.—Annual pruning is necessary if annual crops are to be expected. If the pruning is neglected the tree will produce crops biennially or less frequently. Pruning should keep the head of the tree low and open and should regulate the amount of fruiting brush left from year to year.

Harvesting.—All olives should be hand-picked. The degree of ripeness depends on the use to which the fruit is intended. If for green pickles, fruit should be full grown but still green in color. For ripe pickles and oil, fruit should be well colored, color varying according to variety. Varieties grown should be confined to those that grow large enough fruit for pickling. Mission, Manzanillo, Sevillano, and Ascalano are the most favored at present.

Labor.—Price of labor will vary from $2 to $3 per day, according to the work done, expert growers and grafters getting the higher price. The picking of the fruit by hand will cost about $20 per ton. One man may care for from ten to forty acres. In any case he will need help at picking and pruning time.

Lands Still Available.—The lower foothills, bench lands, and alluvial fans and, in the warmer sections, the well-drained bottom lands of situations mentioned under "Regions."

Commercial Value of Developed and Undeveloped Land.—Developed land is valued at from $300 to $600 per acre; undeveloped land at from $25 to $300 per acre, price depending on location, character of the land, cost of levelling, etc.

Marketing.—For the most part olives are sold directly to the canners and oil makers. Some growers have their own plants for pickling, but oil making requires such expensive machinery that very few individuals have them. There is little money in oil, so that the present tendency is to grow only such varieties as are good for pickling. Oil is a by-product. Only the undersized and frosted olives are now turned into oil.

PEAR CULTURE

By RALPH E. SMITH, Professor of Plant Pathology

Soil and Climate.—The best pear soil is deep and rather heavy, with plenty of moisture. Alluvial river bottoms and moist clay-loam foothill slopes characterize our chief pear sections. The tree will stand more drouth, moisture, and alkali than most fruits, however, and thus is often used to fill in low, wet or slightly alkali spots or sloughs in orchards of peaches or apricots where the latter trees would not live. Pears are not very particular as to climate, flourishing equally well near the coast, in the interior valleys, and among the foothills. Irrigation is usually needed.

Districts.—The greatest acreage of pears in California is to be found in the central coast valleys, the Sacramento Valley and adjacent regions and the Sierra foothills of El Dorado, Placer, Sacramento, and Nevada counties. San Jose, Sacramento, Placerville, Marysville, and Anderson are centers of production.

Culture.—The Bartlett is the principal and most exclusive variety grown in California. A few others like the Winter Nelis are sometimes quite profitable, but their culture is exceptional. French seedling has been the usual rootstock, but the Japanese pear is coming into use on account of some resistance to blight and wooly aphis. Pears are planted about twenty-four feet apart, or seventy-five trees per acre. The trees cost about twenty cents each in quantity. Six to eight years is required to commence commercial bearing. The trees are long-lived and very hardy. Other crops may be grown between while the trees are young. Orchards should be plowed in spring, irrigated from two to five times according to locality, and cultivated frequently. Severe pruning is necessary. The tree when planted should be cut back to a height of twenty inches and each year's growth thereafter should be shortened to a length of twelve to eighteen inches, thinning also to a framework of three to five, frequently branched main limbs. Lateral branches should be headed in to produce fruit spurs. Fertilization is not much practiced and is often undesirable on account of making the trees more susceptible to blight. Spraying is necessary to control scab, codling worm and other pests. The usual practice is a late winter application of lime-sulphur just before the growth starts, one combined spray of Bordeaux mixture and lead arsenate after blooming, and one or two later sprayings with lead arsenate.

Harvesting.—The fruit is picked carefully from the tree by hand when "hard ripe."

Marketing.—There are three principal uses for California pears: canning, sun-drying, and shipping fresh. The Bartlett is preeminent on account of its suitability for all of these purposes. The fruit is shipped to the canner in loose boxes. Drying is often done by the grower himself. For shipping, each pear is wrapped in paper and they are then packed carefully in standard sized boxes.

Cost of Production.—Production and harvesting expenses vary widely, but $75 per acre is a fairly liberal average of yearly expense with good care.

Returns.—Production of trees ten years of age and up varies from three to ten tons per acre, and the usual price from $25 to $40 per ton. The foothill districts of smaller yield per tree make up to some extent by high shipping quality of the fruit. Groves average from ten to one hundred acres.

Cost of Groves and Land.—Good pear land, with water, can be bought at from $60 to $200 per acre, and producing groves are worth from $300 to $1000, *Labor.*—Laborers receive from $1.75 to $2.50 per day. Man and team, $3.50 to $5.

Troubles.—Two diseases, blight and scab; an insect, codling worm; and an occasional late frost are the chief obstacles to pear culture. Scab and worms can be controlled by spraying. Blight is a very serious enemy and has ruined thousands of acres of pears in California and elsewhere. Pear planting is somewhat hazardous on account of this disease, although it can be fairly well controlled by very careful work. Control is effected by very thorough removal of affected parts, especially during the winter. The disease is extremely infectious. Partially resistant trees are being developed. Special information should be sought in blight control.

POTATO CULTURE

By JOHN W. GILMORE, Professor of Agronomy

The principal regions are in the delta lands of San Joaquin and Contra Costa counties, and the Salinas Valley of Monterey County. Those desiring to investigate this industry would do well to visit the regions in the vicinity of Middle River, Holt and Stockton for the delta country, Blanco and Salinas (Monterey County) and Sebastopol (Sonoma County) for the other regions. There is, also, a considerable acreage in Los Angeles, Orange, and Imperial counties.

The delta region consists of lowlands which for a long period of time have been inundated by the high waters of the Sacramento and San Joaquin rivers. They have been overgrown by juncus (tule) and other marsh plants. These marshes have been reclaimed by constructing levees along the water courses and then by electrically driven pumps the water has been removed to a level sufficiently low to grow crops. The soil consists of partly decomposed vegetable matter mixed with sediment from the overflows, and in this form it is loose and friable and permits the ready movement of water. The soil is well suited not only to potatoes, but to onions, asparagus, beans, and barley.

Because this soil is very rich in organic matter, and because of its loose texture and abundance of moisture, diseases that affect the potato thrive readily. These do not often materially damage the first crop, but they are sufficiently prevalent to infest and multiply in the soil, so that future crops are often greatly reduced. The disease causing the most trouble is the Rhizoctonia. It infests the soils from year to year, and while it affects the tubers it does not render them unfit for use. Its principle effect is upon the young shoots which after becoming thoroughly diseased die before the tubers are formed, but too late in the season for replanting. The only effective remedy against this disease now known is to plant the land to non-affected crops until the disease is starved out. It is estimated that this disease causes an annual loss to potato growers in this region of from 20 to 25 per cent of the crop, or a money loss of nearly, if not fully, a million dollars.

Wilt disease (caused by Fusarium and Verticilium) is also very common in this region and attacks both the tubers in the soil and the growing stems just below the surface. The disease has the effect of cutting off the water supply to the growing parts of the plants from the roots. The disease also produces conditions favorable for the infestation of the tubers and stems by other diseases. The use of disease-free tubers for seed and the witholding of potatoes from the land for a period of years are the only practicable remedies against the disease.

Scab also causes considerable loss in the field as well as after digging. This disease may be held in check by planting disease-free tubers and by practicing a long rotation, which prevents the disease from thriving in the soil.

In this region the land is generally plowed in the fall or winter and again at planting time. Planting begins in March and continues into June and sometimes into July, though this is well known to be too late for good results. As a general rule the planting is accomplished by hand, dropping the seed pieces behind the plow every second or third round. As this is very strong land the potato crop is often affected by weeds, and much of the labor of growing the crop is expended in their destruction.

The yields in this section vary greatly. The factors which influence the yield are diseases, lack of storage facilities for seed and the culture methods, especially the preparation of the land and the rotation of crops. Because of these factors the yield varies from 65 to 750 bushels per acre.

There is a tendency to grow potatoes continuously for as long a period as possible, for this crop pays better returns when not affected than most other crops. It has not been found possible to do this, however, without incurring greatly diminished yields. Consequently, successful potato growing in this region is contingent upon adopting culture methods, especially in respect to rotation crops that will keep the soil bare from the disease.

Much of this land is held by companies or by single owners in large tracts. It is usually rented to Japanese or Chinese tenants at from $20 to $35 an acre, or when on shares, for one-third of the crop. The cash rental of land for potatoes, however, is the more usual method. Where labor is hired it is generally Japanese or Chinese and wages commonly paid are $2 to $2.50 per day. The intrinsic value of these lands depends upon the prevalence of disease in the soil and the equipment of the farmer for using other crops profitably in rotation. But little of this land is for sale, but that which is for sale is held at from $300 to $500 per acre.

A good deal of land in this section still remains to be reclaimed, but it can only be done at considerable expense and by companies or individuals not demanding immediate returns on the money invested.

Salinas Valley.—The conditions under which potatoes are grown in this region are typical of other portions of the state. They differ, however, from those in the delta region, principally in respect to the nature of the soil and lesser prevalence of disease. The soil on the other hand is not so productive. The yields vary from 60 to 200 bushels per acre. The average is about 100 bushels, but on reasonably good land and by practicing good cultural methods, about 150 bushels may be counted upon. In this section much of the potato land is rotated with sugar beets. The deep rooted nature of both of these crops and the tillage methods keep the land in good tilth and in good producing capacity.

In both of the sections mentioned potatoes are harvested both by hand and by machine diggers and are marketed in sacks weighing about 110 pounds, the price ranges from 90 cents to $1.65 per sack (50 cents to 90 cents per bushel).

In any section of California the successful production of potatoes depends most largely upon the prevalence of a deep loam soil well supplied with moisture and free from disease infestation. The interior valleys where the temperature during the growing season is excessively hot must be avoided, for the potato thrives best in a cool soil.

PRUNES

By THOMAS FRANCIS HUNT, Assistant Superintendent of Farmers' Institutes

''All prunes are plums, but all plums are not prunes. A prune is a plum which can be dried without the removal of the pit without fermenting.'' The prune belongs to the genus *Prunus,* of which there are a great many cultivated varieties. Some of the most common grown commercially are the Prune d'Agen, Robe de Sargeant, German prune, Imperial, Sugar, Giant, and Silver.

The culture of prunes constitutes a very large branch of California horticulture because the prune is a standard article of diet and is marketed as fresh and dried fruit. More prunes are sold than any other dried fruit in California. The range of soil and climatic conditions for the prune is very large. They are grown successfully in the Valleys near the coast (not on the coast), as in the Santa Clara Valley, Santa Rosa, Napa, and other of the smaller valleys. In the San Joaquin and Sacramento valleys, where conditions are quite different, we find prune orchards doing well, as in the vicinity of Hanford, Visalia, Vaca Valley, Yuba City, and Chico. Smaller areas are found in the foothills near Auburn and Newcastle, where they do well.

Soils—The prune is grown generally in deep, fertile, well-drained soils, not too sandy nor too heavy like the clays and adobes. Because the tree is quite adaptable, a great many are planted on soils that are not suitable, such as the light sands, clays and adobes, and under these conditions the trees grow with varying degrees of success. In selecting a soil for prunes, there are certain things one should observe very carefully before planting, and try to avoid. The soil should be deep, not underlaid with hardpan, standing water, strata of coarse gravel, or impervious clay near the surface. The physical condition of the soil in regard to humus and plant food is also important. One may not always be able to get a soil where all these conditions are ideal, but should select as nearly this type as possible. The conditions to avoid named above are quite often improved by deep plowing, the use of explosives, drainage, barnyard manures, and green manure crops. These factors will have an important bearing on the value of the land. Unimproved land in sections of the state where the industry is highly developed, as in the Santa Clara Valley, sells for $150 to $350 an acre. Improved lands in these sections bring from $450 to $650 per acre. In the San Joaquin and Sacramento valleys, unimproved land brings from $100 to $200 per acre and improved land brings from $250 to $400.

Developing.—There is quite a choice of locations and one should take into consideration climatic conditions in regard to one's personal comfort, price of land in various sections, returns from crop, amount of money to be invested, and income desired. The high priced land is found where the industry is highly developed and where living conditions are particularly desirable, as in the counties along the coast. Good prune land, not so high priced, can still be obtained along the streams in the San Joaquin and Sacramento valleys. Still cheaper lands adapted to prunes, usually in small tracts, can be obtained in the foothill sections of the state. In all of these three general sections, prune growing is usually beyond the experimental stage, so that with a given type of soil selected and the local experience in regard to varieties for that locality, one can proceed. The trees can be propagated in several ways, but budded trees are universally used. Several stocks may be used for various soil conditions, but experience has taught that the Myrobalan root is generally used, particularly if the soil is heavy or drainage conditions are bad. The peach and almond root are used considerably, on the lighter soils and where the drainage is good. It is usually better to obtain trees from some reliable nursery firm, of which there are a great many in the state. The trees are planted in squares, rectangles, or triangles. The usual distance is twenty-two to twenty-six feet, depending on local conditions, varieties, etc. The general practice is to cut the tree back to a single stock twenty to twenty-four inches high at the time of planting, then shape the tree, by pruning, the next two or three years. Others do not prune at all, but let the tree grow as it will. The cultural methods will vary a little in different sections, but is not unlike the general care given other orchards in regard to plowing, cultivating, and irrigating.

Handling the Crop.—There are three general methods of handling the crop. These are governed usually by the size of the farm. The first and most common is the case of the owner who has ten or twenty acres and he and his family do all the work, with perhaps, additional help at harvest time. The second class is of large tracts of from twenty to one hundred acres, which are handled almost entirely with hired labor. Third, the renter. In this case, the land is rented for a cash rental, or on a crop basis, which is usually one-third to one-half for the man who rents and one-half to two-thirds to the owner. The labor is supplied chiefly by white people who live in the community and by transients, mostly Orientals, who are employed during the rush season. The fruit ripens on the tree and falls to the ground, when it is gathered, hauled to the dipping shed, dipped in a solution of lye, and placed on trays in the sun to dry. After the fruit has been dried, it is put in sacks and sold to the large packing concerns, or handled by the farmers' co-operative organizations.

Insect Pests and Diseases.—The prune, like other fruit trees, is attacked by certain insects and diseases. The most serious insect pests are thrips, root borers, and red spider. The worst diseases are crown gall and gummosis.

SEMI-TROPICAL FRUITS

By I. J. Condit, Instructor in Citriculture

The following semi-tropical fruits, aside from citrus fruits, olives and figs, are now being grown in California, and are of sufficient importance to warrant commercial plantings: Pomegranate, guava, feijoa, loquat, Japanese persimmon, avocado, and date. All these crops require irrigation.

The pomegranate is grown more or less commonly throughout California except at elevations above 1500 feet. As a commercial fruit it is now found in the Imperial and Coachella valleys and other parts of Southern California, and in the San Joaquin Valley; at Lindsay and Porterville it is largely planted as a border around citrus orchards, thus serving both ornamental and commercial purposes. The guava is commercially grown in San Diego, Los Angeles, Orange, and Santa Barbara counties.

The feijoa is a new fruit introduced into California in 1901; it is closely related to the guava and is sometimes known as the pineapple guava. It is quite hardy, not being injured by a temperature as low as 5° F. A few commercial plantings have been made both in Southern California and in the San Joaquin Valley, but these are mainly experimental.

The loquat is one of our neglected fruits. While it has been grown in California for more than sixty years, and is found widely distributed over the state as a dooryard and ornamental tree, the planting for commercial purposes is practically limited to Orange County, where there are several orchards of five to fourteen acres in extent.

The Kaki or Japanese persimmon is a deciduous tree and therefore is not so liable to frost injury. It is grown commercially to a limited extent along with loquats, citrus fruits, and avocados in Orange and Los Angeles counties, while plantings of a few trees for home use are found in nearly all parts of the state.

The avocado is one of the newer fruits which is creating a great deal of interest at the present time, especially in Southern California. Experimental plantings are being made in Butte County and in some parts of the San Joaquin Valley as well.

Date growing in a commercial way is restricted to the hotter parts of the Imperial and the Coachella valleys.

SUGAR BEET CULTURE

By R. L. Adams, Assistant Professor of Agronomy

Sugar beet culture is confined to the vicinity of sugar beet factories, their culture seldom proving profitable at a distance greater than one hundred miles from a factory. Their growing can therefore best be investigated in the territory surrounding the factories at Alvarado, Anaheim, Betteravia, Chino, Hamilton City, Huntington Beach, Oxnard, Spreckels, Santa Ana, and Visalia.

Since the first six to eight tons of beets produced are required to pay the cost of production, only soils capable of yielding good crops should be selected. Soils should be avoided which are shallow, poorly drained, of poor texture, high in alkali, lacking in plant food or humus, or incapable of adequately supplying the moisture requirements of the crop.

Land for sugar beets usually commands high prices—$200 or more per acre—but can be rented on a share or cash basis, the former requiring as payment one-fourth or one-fifth of the crop, the latter about $15 per acre. Where sugar beets are the primary crop the farms range from 60 to 400 acres in size. As a rule, however, 100 acres may be considered the unit farm.

Sugar beet culture requires a high grade of work stock and special equipment, amounting in all to about $2000 for each hundred acres.

Land to go in sugar beets should be put in a fine state of cultivation by the complete eradication of former crops—as alfalfa or the subjection of raw conditions—as preceding beets with some other crop on newly broken lands. It is essential to plow as deep as is consistent with the past handling of the land and to work down to a fine, firm seedbed. The common practice is to do the bulk of the heavy work in the fall after applying an irrigation, or early in the rainy season after sufficient moisture falls to start the weeds and bring the soil into the proper condition for working. The land is occasionally worked over until seeding time, which ranges from November to May, depending on the section, the bulk of the seeding, however, being done in February and March.

The seed is drilled with machines rented from the factories. These seeders plant either four or eight rows at a time at distances varying from 18 to 28 inches, the 22 inch and 24 inch sizes being most popular.

Cultivation starts as soon as the rows can be seen and is repeated as conditions demand until the crop is laid by. When the plants have four true leaves they are thinned to distances which leave the remaining plants at from eight to twenty-four inches apart, the distance depending on the strength of the soil and the available moisture—the most common distance being ten to fourteen inches.

Irrigation is given to supply ample moisture during the growing periods with a lessening amount at time of maturing. Some lands need but a single irrigation previous to seeding to carry the crop through, while others require several applications during the growing period of the plants.

When the leaves turn yellow and a test indicates a satisfactory degree of maturity the beets are ready for digging. Specially designed plows loosen either one, two or more rows at a time, when the beets are pulled, several rows thrown together, topped, at the junction of the green top with the creamy yellow root and hauled or shipped at once to the factory.

The work of thinning, hoeing weeds, cleaning ditches, pulling, topping and loading the beets is ordinarily done by Japanese, Hindus, or Mexicans working on a day or contract basis—the sliding scale contract based on tonnage produced with bonus provision as a rule giving the best mutual satisfaction. The contract price ranges from 85 cents to over $2 per ton, according to the yield per acre, with a general average price of perhaps $1.25.

The beets are delivered to the factory under a contract drawn up previous to planting, under the terms of which, among other things, the factory agrees to accept all beets coming up to a certain standard—usually set at a minimum of 12 per cent sugar content and 80 per cent purity, with a maximum weight limit of four pounds. These beets are paid for on either a tonnage basis or on the sugar content at prices designated at the time the contract is drawn.

Each factory employs the service of a thoroughly trained agriculturist who stands ready to advise and assist all growers in every way possible.

WALNUT CULTURE

By Ralph E. Smith, Professor of Plant Pathology

Soil and Climate.—Fairly heavy soil is needed and walnut culture is not advisable on that which is sandy, dry, shallow, or ''alkaline.'' The best soils are dark colored, muddy when wet (but not of stiff clay), six feet or more in depth to water, hardpan, sand, or other unfavorable strata, and well drained.

Climatic disadvantages are late spring frosts and extreme summer heat. Different varieties are adapted to various conditions in these respects, if not too extreme. Walnuts require a considerable amount of water. They can be grown without irrigation in some places, but it is usually better to have water.

Districts.—The principal walnut groves of the state are located between Santa Barbara and Santa Ana. The industry is now developing in some of the northern counties. Whittier and Santa Barbara are important centers of production, while San Jose, Walnut Creek, Stockton, and Santa Rosa represent the northern districts.

Culture.—The first essential is a proper choice of variety for a given locality; the beginner should seek reliable advice from the Agricultural Experiment Station or elsewhere. The northern California black walnut is the usual root. The older groves of the state are of seedling trees, but these are no longer planted. Franquette, Mayette, Concord, Eureka, Placentia Perfection, and El Monte are the best varieties. Promising new varieties are appearing. Trees cost from 75 cents to $2 each. Some plant black walnuts in orchard form to top graft later; this method is only of advantage where no irrigation can be practiced. Planting averages 50 x 50 feet, requiring seventeen trees per acre. Young groves may be interplanted with alfalfa, tree or small fruits, vegetables, or other crops, provided plenty of water is available. Producing groves are usually plowed in spring, irrigated in June, August and in winter if the rainfall is short, and cultivated after irrigation and occasionally between. Little pruning or fertilization is practiced, although desirable in older groves. Spraying is commencing to be practiced in some sections against two pests, the blight and aphis. Walnuts should pay expenses by the fifth year after planting and reach good bearing at ten. The production should continue to increase for many years; the tree is long-lived and fairly hardy.

Harvesting.—The nuts ripen in September and October and are picked from the ground after light shaking of the trees. They are then usually washed, dried in the sun, bleached and graded. In the south, most of the growers belong to co-operative associations with central packing houses, where the nuts are bleached, graded and shipped.

Marketing.—The demand for walnuts is greater than the supply. Prices are established by the associations and the crop sold through brokers. Independent growers easily sell to private customers.

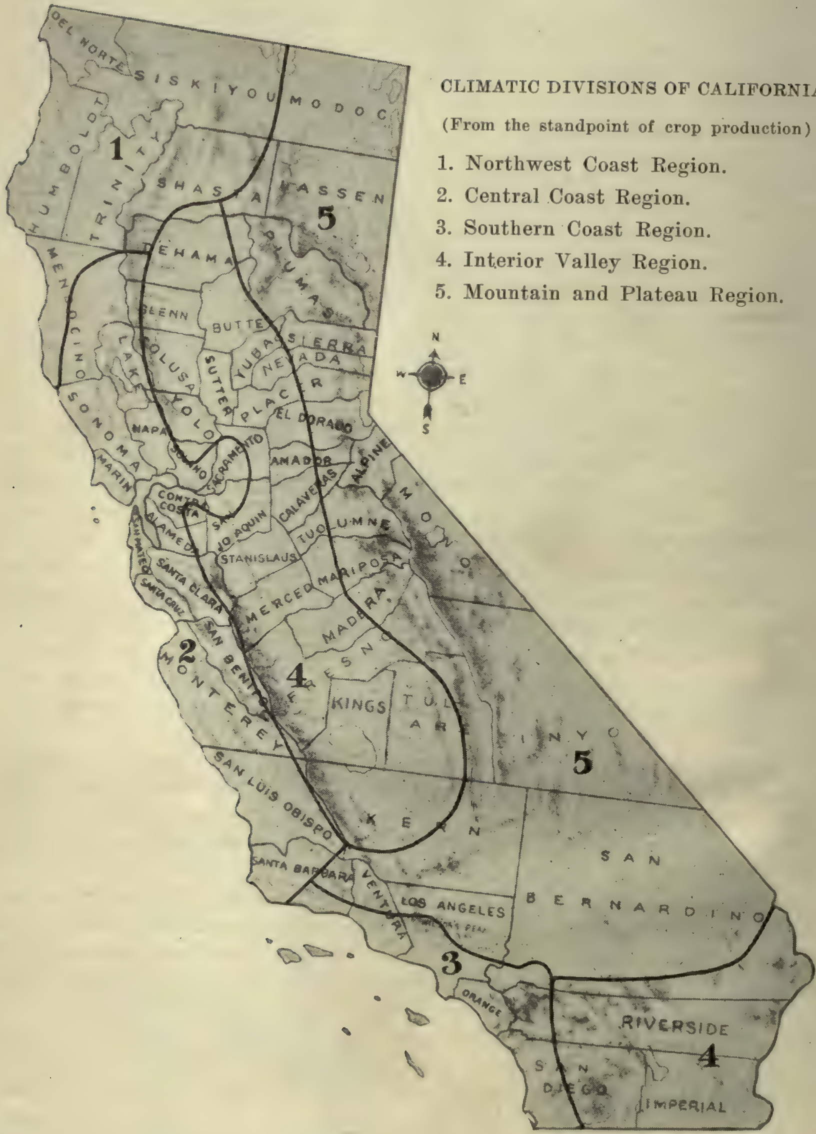
Cost of Production.—Harvesting, preparing and marketing the nuts averages three cents per pound. Production expenses vary from $10 to $50 per acre, averaging nearer the lower figure. Taxes and interest on the investment must be added.

Returns.—Groves average 1000 pounds of nuts per acre per year, with an average selling price of 12½ cents per pound for all grades and sizes. The better varieties frequently produce 2000 pounds per acre and average 16 cents per pound. Greater returns are exceptional. This gives a net income of say $80 to $200 per acre. Groves average from ten to forty acres.

Cost of Groves and Land.—Walnut groves in Southern California can be bought for $700 to $2000 per acre. One thousand dollars is an average price. In this section good bare land with water costs at least $400 per acre and usually more. In the central or northern portion of the state $150 to $300 per acre are average prices for desirable land with irrigation possibilities.

Labor.—The crop is well adapted to a working family. Father or sons can do the heavy work, while women and children can pick up the nuts. Labor costs about $2.25 per day for able-bodied men, or $5 per day for a man and team.

Troubles.—These are due principally to sandy or shallow soil, lack of water, improper varieties, bad treatment, injurious climatic conditions, and the disease called blight. These conditions can be largely avoided by proper choice of locality and varieties, and good culture.



CLIMATIC DIVISIONS OF CALIFORNIA

(From the standpoint of crop production)

1. Northwest Coast Region.
2. Central Coast Region.
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CALIFORNIA
STATE BOARD OF FORESTRY

BULLETIN No. 5

A Discussion of Log Rules

Their Limitations and Suggestions for Correction

BY
H. E. McKENZIE

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COLLEGE OF AGRICULTUR
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PREFACE

THE lumberman is beginning to realize the necessity for standardizing the methods employed in handling his industry. We recognize the problem of standardization as a broad one and feel that the following discussion of log rules is an appropriate contribution to the solution of a problem which influences both the commercial handling of lumber and the scientific study of forest products. There is an unquestionable need for a standard rule for the accurate determination of the volume of logs of various lengths and diameters, and the amount of manufactured lumber possible to produce from such logs. There are many log rules in use throughout the United States, some more accurate than others.

The following discussion has been prepared by Mr. H. E. McKenzie, Forest Engineer with this department, and was suggested by the result of a mill scale study (to be issued as a separate publication) in which the statute rule of California, the Spaulding Log Rule, was found to show a marked discrepancy between the log scale and the amount of lumber sawed out. This discrepancy led to the further investigation embracing all of the log rules in use in the United States, with the view of determining what rule, if any, is universally applicable or to devise such a rule.

G. M. HOMANS,
State Forester.

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DISCUSSION OF LOG RULES

INTRODUCTION

IT is customary among the lumbermen of this country, when buying or selling logs, to base their calculations upon the value of the lumber the logs will produce when sawed rather than upon the total volume. The by-products, such as slabs, sawdust, and loss by normal crook, which accompany the manufacture of lumber from logs of various sizes, are therefore ignored in the valuation, and tables have been compiled which aim to show the volume of lumber in units, known as board feet (1″x 12″x 12″), after the elimination of by-products has been made. Such tables are called "log rules."

It is the object of this publication to discuss many of the different log rules now in use, to show the principles upon which they are based, and wherein they are defective; to introduce a new log rule, based upon mathematical principles, and designed to be flexible to the varying conditions, both in milling operations and in the character of the timber to be sawed. Also, to show relations, where they exist, between any two rules or any number of rules, such that a transformation from one rule to another can be accomplished, and to reduce the various rules, wherever possible, to a definite form, in order that comparisons by formulæ may be easily made, and the allowance for slabs, sawdust, etc., by each rule readily ascertained.

CONSTRUCTION AND UNDERLYING PRINCIPLES OF LOG RULES.

LOG RULES IN GENERAL.

About forty-five log rules have been devised within the last seventy-five years for the measurement of sawed lumber from logs of different sizes, and the values shown by these different rules cover an enormous range. It is safe to say that 90 per cent of them are so constructed that at best they are of value only under the conditions of the locality where they were first employed, and there is no means whereby they can be intelligently corrected for other conditions. Such is the case with all log rules based upon diagrams showing the amount of lumber in logs after allowances have been made for slabs, saw-kerf, etc. Such is the case with all log rules obtained by correcting these rules or combining them for others. Also rules resulting from actual experience at sawmills have the same objections. They bear the prints of local conditions and, due to the method whereby they came into existence, they can never be anything more than local, and can only be applied to milling conditions similar to those existing at the mills where they were first constructed.

The only logical way of constructing a log rule which will be flexible and which will adjust itself to universal conditions, is to so construct it that the underlying, fundamental principles are so segregated as to make them independent of one another, and to have them so worked together as to give the aggregate result of all factors, which will be in all cases proportional and equal to the volume of the manufactured product. There are several distinct principles underlying the measurement of lumber which logs of different sizes will produce, which cannot be overlooked in any rule that is destined to become a correct universal measure. Such a rule must embody the principle that the slabs which cover the material, or part of the log which is to become the finished product, should be allowed for by making the allowance proportional to the barked area of the log. The slabs are the covering, as it were, which necessarily has to be removed in order to get to the part of the log that produces lumber, and they should not be, and are not, cut any thicker from large logs than from small ones. The best material contained in the log usually lies nearest to the bark, and it is greatly to the advantage of the millman not to waste any of his best grades.

Several log rules in most common use today do not embody the above principle. The Spaulding Log Rule, which is the statute rule of California, does not adhere to it. The Scribner Rule, which is the official rule of the Forest Service, U. S. Department of Agriculture, and of several states, does not take it into consideration, and instead of having the volume of slabs proportional to the barked area of the logs, they have them proportional to the total volume, as will be shown further on.

It would not be any more absurd if one tried to figure the number of board feet necessary to side up a house by figuring the volume of the house instead of its lateral surface. A definite per cent cannot be given as indicating the relation of slabs to trees of different volume, any more than a definite per cent can be given as indicating the relation of all lateral surface to the volume of houses of different dimensions. The Spaulding, Scribner and all other log rules with a waste allowance for slabs varying directly as the volume of the log are mathematically incorrect, since there is no reason for cutting any thicker slabs from large logs than from small ones.

Another principle underlying the measurement of lumber contained in logs of different diameters and lengths is the relation of the allowance for sawdust to the size of the log. Since the waste allowance which should be allotted to slabs should be proportional to the barked area, it can be met by reducing the diameter of all sized logs a constant amount, and the remaining volume can then be considered as lumber plus sawdust. It is very evident that the sawdust allowance depends upon the dimensions of the lumber to be sawed and upon the width of the saw used. It is also evident that, for any specific width of saw-kerf and dimensions of lumber to be sawed, the allowance for sawdust should be a definite per cent of the total volume of all logs, not including slabs. A sawdust factor which fulfills these conditions is as follows:

$$\frac{k\,(w+t+k)}{(w+k)\,(t+k)}$$

Where $k =$ width of saw, in inches.
$w =$ average width of lumber to be manufactured, in inches.
$t =$ average thickness, in inches.

This factor shows what fractional part of the log minus allowance for slabs should be allowed for sawdust.

$$\left[1 - \frac{k\,(w+t+k)}{(w+k)\,(t+k)}\right]$$

represents the fractional part of the log after slab allowance is made, which becomes lumber.

Log rules which ignore these principles can not be any more than local rules, applying to conditions existing at very few mills.

There are several other considerations to be taken into account in constructing a log rule, which are not of such vital importance as the two principles cited above. They are allowances for taper, shrinkage, normal crook and excessive taper in small logs. All of these factors depend largely upon the character of the timber, and should be adjusted accordingly for the different species, and for the same species growing under different conditions.

THE THREE RULES MOST COMMONLY USED.

The Spaulding Log Rule.

The Spaulding Log Rule is the statute rule of California, having been adopted by an act of the legislature in 1878. It is constructed from diagrams, and the following comments upon it were published by its author:

> "Each sized log has been scaled so as to make all that can be practically sawed out of it, if economically sawed. Each log to be measured at the top of small end, inside of the bark, and if not round, to be measured two ways—at right angles—and the average

> taken for the diameter. Where there are any known defects, the amount to be deducted should be agreed upon by the buyer and the seller, and no fractions of an inch to be taken into the measurement.
>
> "In the foregoing table I have varied the size of the slab in proportion to the size of the log, and have arranged it more particularly for large logs by taking them in sections of twelve feet and carrying the table up to 96″ in diameter. As there has never been any in use for scaling over 44″, it has been my purpose to furnish a table for the measuring of logs that can be implicitly relied upon for correctness by both the buyer and the seller; and to do so, I have spared no pains to render it perfect."

This rule has been very carefully prepared, and all values given are very consistent with the principles upon which it is constructed. These principles are clearly shown in the graphic analysis made of the rule in Fig. 1. They are as follows: (a) The sawdust allowance varies directly with the volume. (b) Slab allowance varies directly as the volume plus a constant. (c) No allowance made for taper. (d) No allowance made for normal crook. (e) Total waste allowance remains constant, regardless of the width of saw-kerf.

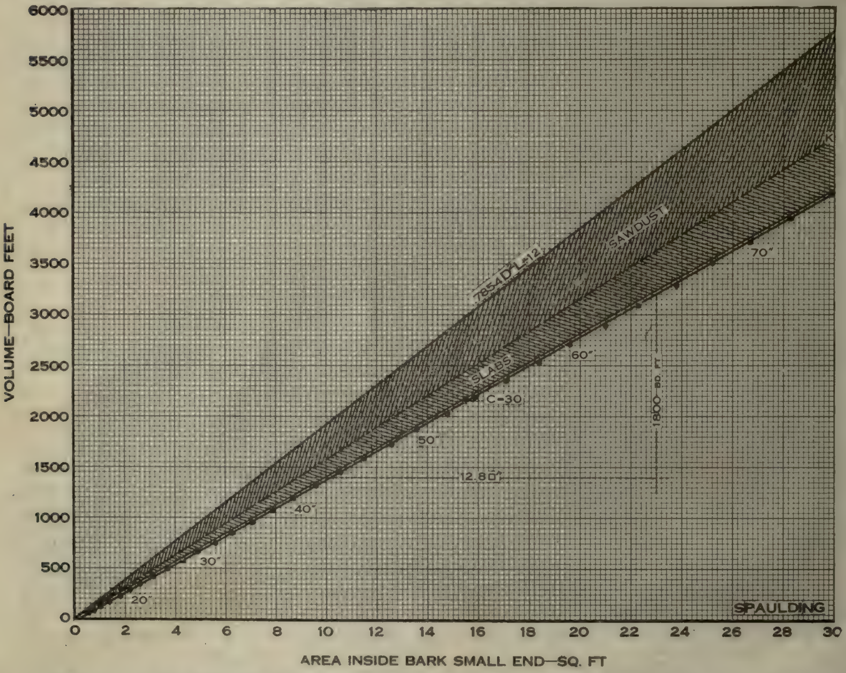

FIG. 1. A graphic analysis of the Spaulding Log Rule, based upon area in square feet inside bark at small end of logs. This diagram shows the following: (*a*) Top curve, total contents in board feet of logs of different diameters 16′ long with no allowance made for taper. (*b*) Curve "k," volume in board feet remaining after 18% of the total volume has been allowed for sawdust (this allowance is about right for ¼″ saw-kerf). (*c*) Curve passing through origin and drawn parallel to bottom curve. (*d*) Bottom curve located by plotting volumes in board feet for 16′ logs of even inches in diameter inside bark, as given by the Spaulding Log Rule. The formula indicated by this analysis is as follows: $(.048D^2 - 2)L = \text{B. M.} =$ volume in board feet.

The big disadvantage of such a rule lies in the fact that it is not flexible to conditions existing at mills in different localities where it might be used, or to the character of the timber sawed. It is unaffected by taper, normal crook, width of saw-kerf and excessive taper in small logs, and such corrections can not be properly made due to the diagram method used in first constructing the rule. Fig. 1 indicates the following formula: $(.048D^2 - 2)L = \text{B. M.} =$ volume in board feet, which very closely fits this rule as shown in Fig. 2.

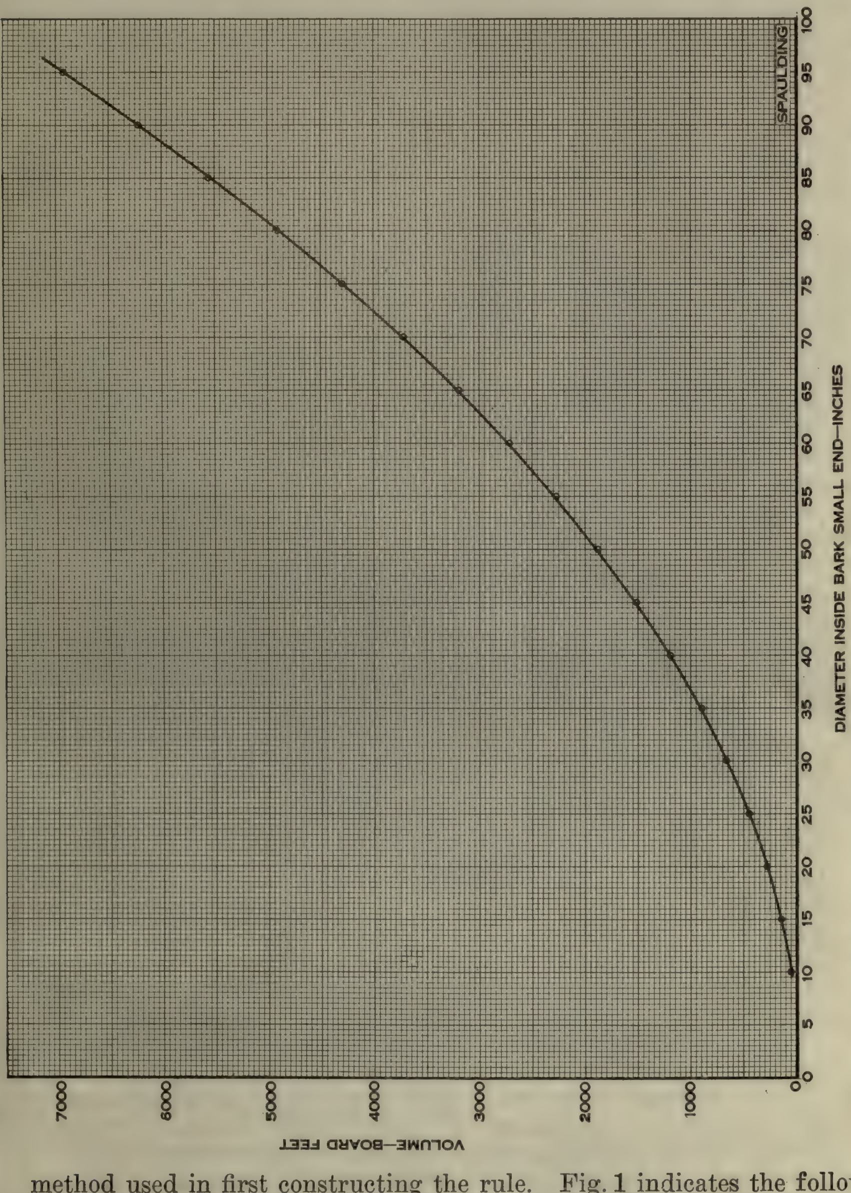

FIG. 2. The curve shown in this figure is a graphic representaton of the formula $(.048D^2 - 2)L = \text{B. M.}$, when $L = 16'$. The points on the curve are plotted independently from values given by the Spaulding Log Rule, the object being to show how closely the formula fits the rule.

Small logs will invariably over-run this scale, due to the constant "2" shown by the formula. Intermediate logs will hold up the scale, fall below, or go above, largely depending upon the width of saw-kerf and the average dimensions of the lumber sawed. Large logs will generally run higher than the intermediate sizes, due to the fact that the slab allowance varies directly with the volume plus a constant. The following deduction shows the total waste allowance of the Spaulding Log Rule expressed in per cent of the rule:

$(.048D^2 - 2)L =$ B. M. $=$ total sawed out as shown by Spaulding Log Rule.

$\frac{.7854D^2}{12}L =$ total contents $= .0655D^2L$

$.0655D^2L - (.048D^2 - 2)L =$ waste $= [(.0655 - .048)D^2 + 2]L$
$= (.0175D^2 + 2)L.$

$100\frac{(.0175D^2 + 2)\,L}{(.048D^2 - 2)\,L} =$ % waste based on total sawed out as shown by Spaulding Log Rule.

$$= 100\,\frac{.0175D^2 + 2}{.048D^2 - 2}.$$

When $D = 10''$, the waste allowance based on the total sawed out as shown by the Spaulding Log Rule $= 134\%$.
When $D = 20''$, the waste allowance $= 52.2\%$.
When $D = 30''$, the waste allowance $= 43.1\%$.
When $D = 40''$, the waste allowance $= 40.1\%$.
When $D =$ diameter in inches of very large logs, waste allowance $= 36.5\%$.

The Scribner Log Rule.

The Scribner Log Rule is the oldest rule in general use, and is the statute rule of Idaho, Minnesota, Oregon, Wisconsin and West Virginia. Also, it is the official rule adopted by the Federal Forest Service.

It was constructed from diagrams the same as the Spaulding Log Rule, and the following description was published by its author in 1846:

> "This table has been computed from accurately drawn diagrams for each and every diameter of logs from twelve inches to forty-four, and the exact width of each board taken after being squared by taking off the wane edge and the contents reckoned up for every log, so that it is mathematically certain that the true contents are here given, and both buyer and seller of logs will unhesitatingly adopt these tables as the standard for all future contracts in the purchase of saw logs where strict honesty between party and party is taken into account. In these revised computations I have allowed a thicker slab to be taken from the larger class of logs than in the former edition, which accounts for the discrepancy between the results given in these tables and those in former editions.
>
> "The diameter is supposed to be taken at the small end, inside the bark, and in sections of 15′, and the fractions of an inch not taken into the measurement. This mode of measurement, which is customary, gives the buyer the advantage of the swell of the log, the gain by sawing into scantling, or large timber, and the fractional part of an inch in the diameter. Still it must be remembered that logs are never straight and that oftentimes there are concealed defects which must be taken as an offset for the gain above mentioned. It has been my desire to furnish those who deal

in lumber of any kind with a set of tables that can implicitly be relied upon for correctness by both buyer and seller, and to do so I have spared no pains nor expense to render them perfect; and it is to be hoped that hereafter these will be preferred to the palpably erroneous tables which have hitherto been in use. If there is any truth in mathematics or dependence to be placed in the estimates given in diagrams, there cannot remain a particle of doubt of the accuracy of the results here given."

This log rule gives practically the same results as does the Spaulding. It is not as carefully prepared, however, since the values given are not as consistent with the underlying principles of the rule. A graphic analysis of it is given in Fig. 3, which shows the fundamental principles upon which it is based, and which are the same as for the Spaulding rule. The formula indicated by the analysis shown in Fig. 3 is $(.048D^2 - 3)L = \text{B. M.} =$ volume in board feet, which is practically the same as for the Spaulding Log Rule, the only difference being in the constant "3". Fig. 4 shows how closely this formula fits the rule.

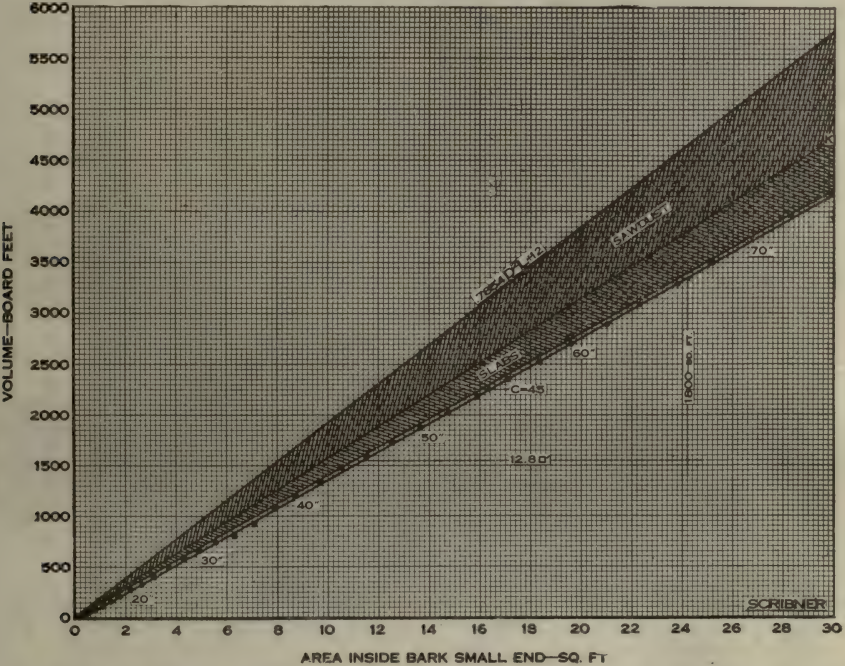

FIG. 3. A graphic analysis of the Scribner Log Rule, based upon area in square feet inside bark at small end of logs. This diagram shows the following: (*a*) Top curve, total contents in board feet of logs of different diameters 16′ long, with no allowance made for taper. (*b*) Curve "k," volume in board feet remaining after 18% of the total volume has been allowed for sawdust (this allowance is about right for ¼″ saw-kerf). (*c*) Curve passing through origin and drawn parallel to bottom curve. (*d*) Bottom curve located by plotting volume in board feet for 16′ logs of even inches in diameter inside bark as given by the Scribner Log Rule. The formula indicated by this analysis is as follows: $(.048D^2 - 3)L = \text{B. M.} =$ volume in board feet. This formula is almost identical with the one obtained for the Spaulding Log Rule. It does not apply, however, to diameters below 14″ or above 75″. No formula can be written for the Scribner Log Rule that will fit all values given, due to the inconsistency of the individual values of the rule.

Small logs will invariably overrun this scale, and to a slightly greater extent than for the Spaulding Log Rule, since the constant shown by the formula is "3" instead of "2". Intermediate logs will hold up the scale, fall below or go above, largely depending upon the width of the saw-kerf and the average dimensions of the lumber sawed. Large logs will run higher than the intermediate sizes, due to the fact that the slab allowance is directly proportional to the volume plus a constant. The following deduction shows the total waste allowance of the Scribner rule expressed in per cent of total sawed out, as shown by the rule:

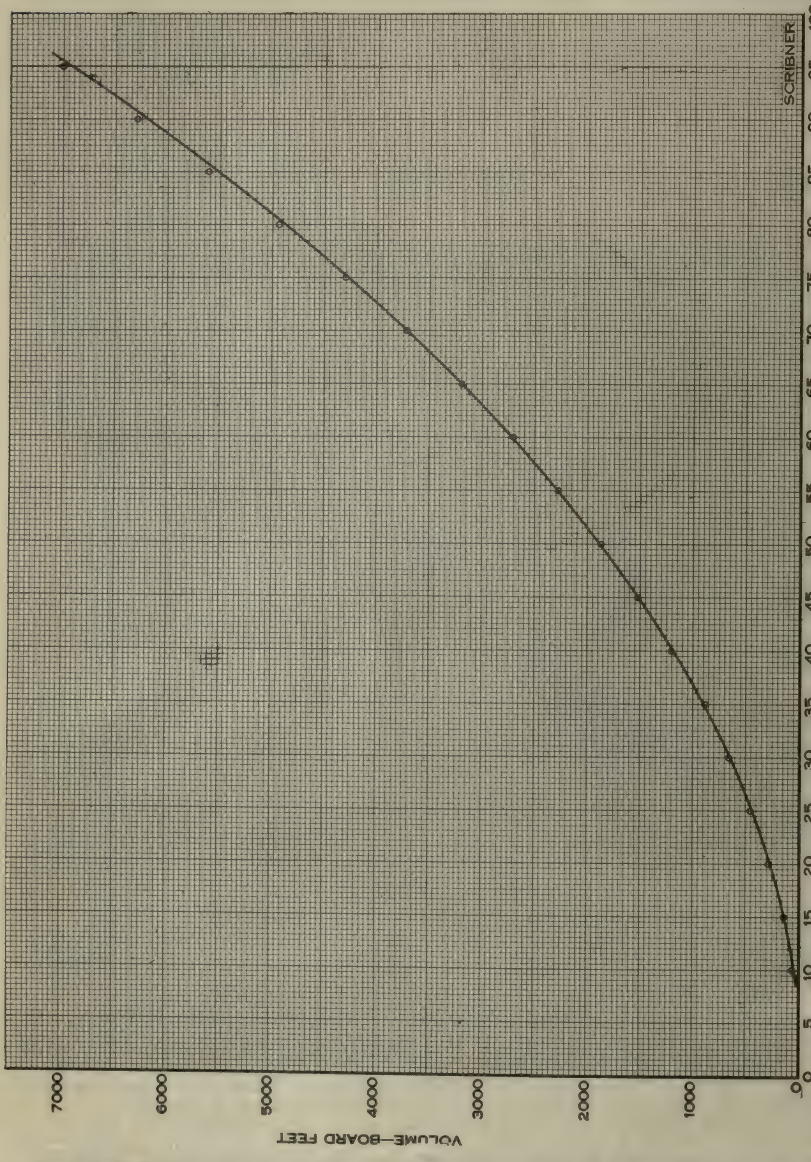

FIG. 4. The curve shown in this figure is a graphic representation of the formula $(.048D^2 - 3)\,L = $ B. M., when $L = 16'$. The points on the curve are plotted independently from values given by the Scribner Log Rule, the object being to show how closely the formula fits the rule. (It does not apply to diameters below 14" or above 75".)

$(.048D^2 - 3)L = \text{B. M.} =$ Total sawed out as shown by the Scribner Log Rule.

$$\frac{.7854D^2}{12}L = \text{total contents} = .0655D^2L$$

$$.0655D^2L - (.048D^2 - 3)L = \text{waste} = [(.0655 - .048)D^2 + 3]L$$
$$= (.0175D^2 + 3)L$$

$100\dfrac{(.0175D^2 + 3)\,L}{(.048D^2 - 3)\,L} =$ % waste based on total sawed out as shown by Scribner Log Rule.

$$= 100\;\frac{.0175D^2 + 3}{.048D^2 - 3}\,.$$

When $D = 10''$, the waste allowance based on the total sawed out as shown by the Scribner Log Rule = (Formula does not apply below 14″).

When $D = 20''$, the waste allowance = 61.8%.

When $D = 30''$, the waste allowance = 46.7%.

When $D = 40''$, the waste allowance = 42.0%.

When D = diameter in inches for very large logs, waste allowance = 36.5%.

The Doyle Log Rule.

The Doyle Log Rule is used throughout the entire country and is the statute rule of Florida, Louisiana and Arkansas. It is constructed from the formula $\left(\dfrac{D-4}{4}\right)^2 L = \text{B. M.}$, which is stated as follows: Deduct 4″ from the diameter of the log as an allowance for slabs; square one quarter of the remainder and multiply the result by the length of the log in feet. No mention is made in this rule of a sawdust allowance. If four inches from the diameter of the small end is the slab allowance, the sawdust allowance must be the difference between the solid contents in board feet remaining after the slab allowance has been made and the contents shown by the rule. The determination of sawdust allowance follows:

$\left(\dfrac{D-4}{4}\right)^2 L = B.M. =$ volume in board feet, as shown by the Doyle rule, of log D inches in diameter at small end inside bark and L feet long.

$\dfrac{.7854\,(D-4)^2}{12}L =$ volume in board feet of log D inches in diameter inside bark at small end L feet long with waste allowance for slabs but none for sawdust.

$\dfrac{.7854\,(D-4)^2}{12}L - \left(\dfrac{D-4}{4}\right)^2 L =$ sawdust allowance for log D inches in diameter and L feet long.

$\dfrac{\dfrac{.7854\,(D-4)^2}{12}L - \left(\dfrac{D-4}{4}\right)^2 L}{\dfrac{.7854\,(D-4)^2}{12}L} \times 100 =$ sawdust allowance for log D inches in diameter and L feet long expressed in per cent of volume in board feet left after slab allowance has been made

$$= \frac{.295}{.0655} = 4.5\%$$

Therefore, the sawdust allowance for the Doyle Log Rule = 4.5% of the total volume left after 4″ has been deducted from the diameter as an allowance for slabs. This sawdust allowance is correct in principle, since it is a definite per cent of the total volume after slabs have been accounted for. It is, however, entirely too small. The thinnest modern band saws take away at least 10% of the volume of the lumber sawed unless the product be large timbers, and the allowance of 4.5% is not one-half as large as it should be for even one of these saws. The principle upon which the Doyle Log Rule is based is correct, however, since the slab allowance is proportional to the barked area and the sawdust allowance is proportional to the total volume left after the allowance for slabs has been made. But the allowance for slabs is absurdly large and that for sawdust is absurdly low. In short, the principle of the rule is correct, but the values are very poorly chosen. Fig. 5 shows a graphic analysis of the rule.

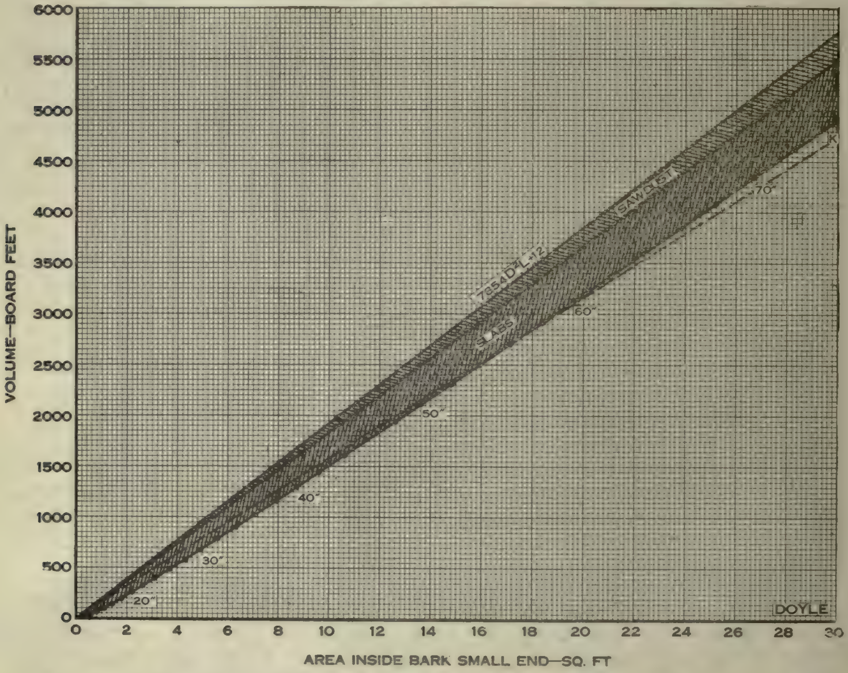

FIG. 5. A graphic analysis of the Doyle Log Rule, based upon area in square feet inside bark at small end of logs. This diagram shows the following: (*a*) Top curve, total contents in board feet of logs of different diameters 16′ long with no allowance made for taper. (*b*) Next lower curve, volume in board feet remaining after an allowance of 4.5% has been made for sawdust. (4.5% of the total volume of logs, after slab allowance has been made, is the only portion of the waste allowance of the Doyle Log Rule that varies directly as the volume. Therefore, it is the only part of the formula that varies directly as the amount of sawdust.) (c) Curve "k," values for volume in board feet after an allowance of 18% for sawdust has been made. This curve intersects the log rule at about 56″, showing, that, at this point and above, the waste allowance which should cover slabs and sawdust is not sufficient to even cover the sawdust. The Doyle Log Rule, however, is correct in principle, but its values are very poorly chosen.

A log rule was used long before the Doyle rule came into existence, which gave the same results, and was stated as follows: Deduct 4″ from the diameter for slabs, then, squaring the remainder, subtract one-fourth for saw-kerf and the balance will be the contents of the log 12′ long, from which the others may be obtained by proportion. It would appear from this that a generous allowance for sawdust had been made, but as a matter of fact the apparent sawdust allowance is a part of the allowance already made for slabs. This is clearly illustrated in figures 6 and 7, when the above rule is applied. (Deduct 4″ from the diameter for slabs and in Figures 6 and 7 we have $D-4=AB$. Then, squaring the remainder $(D-4)$, we have $(D-4)^2=ABCD$. Subtract $\frac{1}{4}$ for saw-kerf, giving $\frac{3}{4}(D-4)^2$, which is the inside circle. The inscribed circle outside of this is equal to $.7854(D-4)^2$. It is apparent from this that $.7854(D-4)^2-\frac{3}{4}(D-4)^2$ is the only true portion of the diagram which could represent sawdust.) This rule amounts to the same thing as the Doyle Log Rule, but in statement is misleading and ambiguous.

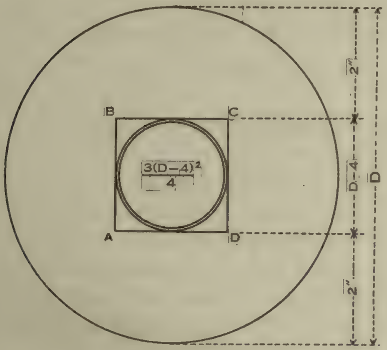

FIG. 6. The Doyle Log Rule as applied to a 6″ log.

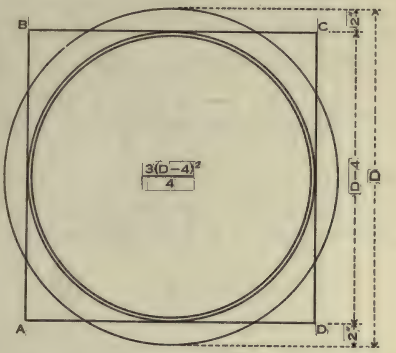

FIG. 7. The Doyle Log Rule as applied to a 30″ log.

The sawdust allowance as shown by Figures 6 and 7 in per cent of total contents after slab allowance has been made is as follows:

$$\frac{.7854\,(D-4)^2-\frac{3}{4}\,(D-4)^2}{.7854\,(D-4)^2}\times 100=$$

$$\frac{.0354\,(D-4)^2}{.7854\,(D-4)^2}\times 100=\frac{3.54}{.7854}=4.5\%$$

which is the same as shown by the Doyle Log Rule formula.

The following deduction will show the total waste allowance of the Doyle Log Rule for logs of different sizes expressed in per cent of total sawed out, as indicated by the rule:

$\left(\frac{D-4}{4}\right)^2 L = B.M. =$ volume in board feet of log D inches in diameter at small end inside bark and L feet long.

$\frac{.7854\,D^2}{12} L =$ total volume in board feet contained in log D inches in diameter and L feet long. (No allowance for taper.)

$\frac{.7854\,D^2}{12} L - \left(\frac{D-4}{4}\right)^2 L =$ total waste allowance.

$$\frac{\frac{.7854\,D^2}{12} L - \left(\frac{D-4}{4}\right)^2 L}{\left(\frac{D-4}{4}\right)^2 L} \times 100 = \frac{.003\,D^2 + .5\,D - 1}{.0625\,D^2 - .5\,D + 1} \times 100.$$

= total waste allowance for log D inches in diameter and L feet long expressed in per cent of used volume.

When $D = 10''$, the waste allowance based on the total sawed out as shown by the Doyle Log Rule = 191%.

When $D = 20''$, the waste allowance = 63.8%.

When $D = 30''$, the waste allowance = 39.5%.

When $D = 40''$, the waste allowance = 29.4%.

When $D = 50''$, the waste allowance = 23.8%.

This waste allowance is obviously too high for small logs and too low for large ones. This is due to the fact that the slab allowance is too generous and the sawdust allowance too small. Small logs will invariably over-run the scale; intermediate logs will usually scale about right, since the large slab allowance makes up the shortage for sawdust; large logs will invariably under-run the scale, because the combined slab and sawdust allowance is too small for waste, though the actual slab allowance is too large for slabs alone.

The McKenzie Log Rule.

The McKenzie Log Rule is based on mathematical principles and is designed to cover all conditions encountered in the manufacture of lumber from logs of various diameters and lengths. All factors influencing the total volume sawed out have been taken into consideration and treated separately, thus making the rule flexible to the varying conditions, both in milling operations and in the character of the timber.

The following factors which affect the mill output from logs of different sizes have been included:

(*a*) Slabs.
(*b*) Normal crook.
(*c*) Saw-kerf.
(*d*) Average dimensions of lumber sawed.
(*e*) Taper.
(*f*) Excessive taper in small logs.

The mathematical principles underlying the rule are as follows:

(*a*) The slab allowance is a function of the barked area and varies directly with it.

(*b*) Normal crook is also a function of the barked area, and varies directly with it the same as slabs.

(*c*) The sawdust allowance is a function of saw-kerf and average dimensions sawed at mill, and for any given saw-kerf and average dimensions the sawdust allowance should vary directly as the volume minus the slabs.

(*d*) Taper allowance equal to e'' in f'. (f not to exceed 16′.)

(*e*) Excessive taper in small logs offset by a constant.

Let $D =$ diameter in inches inside bark at small end.
Let $L =$ length of log in feet.
Let $k =$ width of saw-kerf, in inches.
Let $w =$ average width of lumber sawed, in inches.
Let $t =$ average thickness of lumber sawed, in inches.
Let $C =$ constant.
Let $a =$ constant.

then $(D - a) =$ diameter of log after an allowance for slabs and normal crook has been made. (Since slabs and normal crook both vary the same, they can be accounted for by the same constant, a.)

$\frac{\pi (D - a)^2}{4} =$ area in square inches of small end of log after the slab and normal crook allowance has been made.

$\frac{\pi (D - a)^2 L}{4} =$ volume in units of $1'' \times 1'' \times 12''$ contained in log L feet long and D inches in diameter after the slab and normal crook allowance has been made. (Taper allowance to be made later.)

$\frac{\pi (D - a)^2 L}{4 \times 12} =$ volume in units of $1'' \times 12'' \times 12''$ or board feet in log L feet long and D inches in diameter after slab and normal crook allowance has been made.

No allowance has, as yet, been made for sawdust. This allowance depends upon the width of saw-kerf and the average dimensions of lumber to be sawed. The saw-kerf from one side and edge of an average board bears the same ratio to that board as the total sawdust from all boards does to the total volume after slab allowance has been made. This is true of all volume becoming sawdust, excepting saw-kerf amounting to $2k(D - a)$, which should be considered as part of the slabs since it varies directly as the barked area, and is the sawdust formed in cutting the slabs.

$k(w + t + k)\frac{L}{12} =$ volume of wood forming sawdust from each average board.

$(w + k)(t + k)\frac{L}{12} =$ volume of sawdust plus volume of average board.

$\dfrac{k(w + t + k)\frac{L}{12}}{(w + k)(t + k)\frac{L}{12}} = \dfrac{k(w + t + k)}{(w + k)(t + k)} =$ fractional part of wood, necessary to make average board, becoming sawdust.

This ratio of sawdust to average board plus sawdust holds for volume of logs minus allowance for slabs.

$\left[1 - \dfrac{k(w + t + k)}{(w + k)(t + k)}\right] =$ fractional part of log, after slab allowance is made, which becomes lumber.

Therefore, $\left[1 - \dfrac{k(w + t + k)}{(w + k)(t + k)}\right] \pi \dfrac{(D - a)^2}{48} . L =$ volume in board feet of lumber of average dimensions from log D inches in diameter at small end inside the bark and L feet long, when saw-kerf is k inches wide.

A constant $C =$ to a few board feet, when added to this formula has a compensating effect for the excessive taper in small logs. Since most small logs sawed are the top logs from medium or large sized trees, they have an excessive taper which can not be accounted for by a uniform taper allowance applied to the whole tree. Therefore, this constant, which in all cases will be very small (not exceeding 10 board feet) is applied and its effect on large logs is negligible, but on small ones it will play an important part in eliminating an accumulative error in total sawed out at the mill.

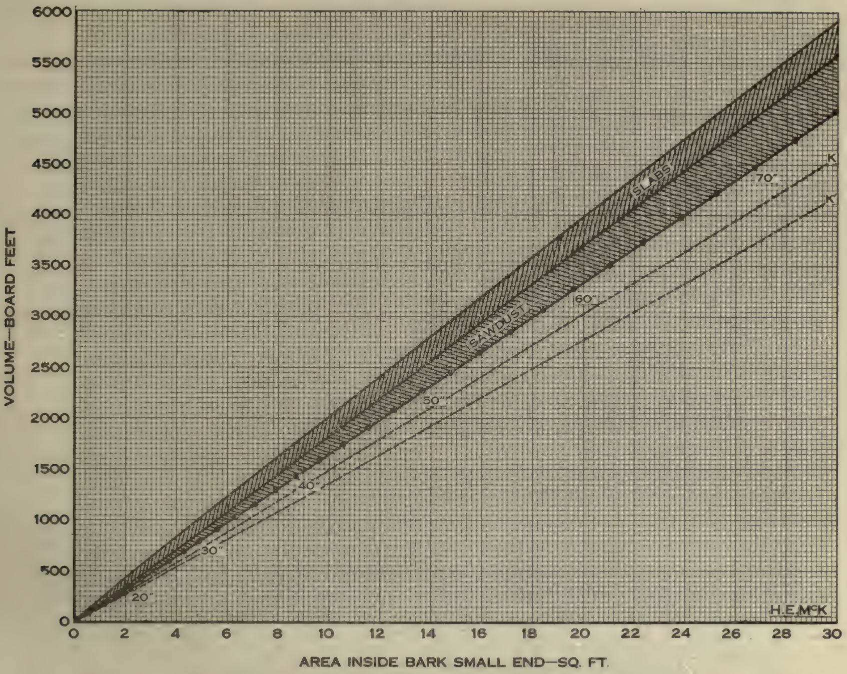

FIG. 8. A graphic analysis of the McKenzie Log Rule, based upon area in square feet inside bark at small end of logs. This diagram shows the following: (*a*) Top curve, total contents in board feet of logs of different diameters 16′ long with taper allowance of 1″ in 8′. (*b*) Next lower curve, volume in board feet remaining after an allowance for slabs has been made. (*c*) The log rule curve for ⅛″ saw-kerf, showing volume in board feet after an allowance for slabs and sawdust has been made. (The allowance for slabs in this rule varies directly as the "barked" area, and that for sawdust directly as the volume minus slab allowance.) (*d*) Curve "k," position that the log rule curve takes when the saw-kerf is ¼″ instead of ⅛″. (*e*) Curve "k′" shows position of the log rule curve for a ⅜″ saw-kerf. The formula for this rule is as follows:

$$\left[1-\frac{k(w+t+k)}{(w+k)\,(t+k)}\right]\frac{\pi\,(D-a)^2}{48}\,L+C=\text{B.M.}$$

k = width of saw-kerf, in inches..
w = average width of lumber, sawed, in inches.
t = average thickness of lumber sawed, in inches.
$\pi = 3.1416$.

D = average diameter inside bark, small end, in inches.
a = constant.
L = length of log, in feet.
C = constant included to compensate for excessive taper in small logs.

The formula is: (not making any allowance for shrinkage and surfacing; the complete formula with this allowance made is shown on page 52.):

$$\left[1-\frac{k\,(w+t+k)}{(w+k)\;(t+k)}\right]\frac{\pi\,(D-a)^2}{48}\,L+C=\text{B.M.}$$

with a taper allowance of e'' in f' to be applied when compiling a table. The section used should not be taken over 16′ long: 8′ is better.

Its Application.

The above formula when applied to conditions existing at the Red River Lumber Company's mill in Lassen County, California, gave results shown in the following table. The value of a determined at this mill is extremely small, due to the fact that slabs were cut very thin and edgings were graded as moulding stock, also to the fact that short lengths were cut from logs where taper was great enough to permit it. The formula was first applied to 16′ logs, thus getting the taper in 16′ included with the slabs. Volumes in board feet of logs of other lengths were then figured with a taper allowance of 1″ in 8′.

TABLE 1. The McKenzie Log Rule, based upon the following formula:

$$\left[1-\frac{k\,(w+t+k}{(w+k)\,(t+k)}\right]\frac{\pi\,(D-a)^2}{48}L+C=\text{B.M.}$$

Where k = saw-kerf = $\frac{1}{8}''$.
Where k = average width of lumber = $12''$.
Where t = average thickness of lumber = $\frac{5}{4}''$.
Where D = average diameter of log inside bark, small end, in inches.
Where $a = 1''$.
Where L = length of log in feet.
Where $C = 2$ = constant allowed for excessive taper occurring in small logs.
Where B. M. = volume in board feet.
Where $\pi = 3.1416$.

With these values substituted, the formula becomes $.942(D-1)^2+2$ = B. M. for 16′ logs.

Table based upon 16′ logs. Taper allowance of 1″ in 8′ made for other lengths.

TABLE I.

Length in feet	Diameter in inches													Length in feet
	4	5	6	7	8	9	10	11	12	13	14	15	16	
	Board feet													
8	4	7	10	15	21	27	35	43	53	63	74	87	99	8
9	5	8	12	18	24	31	40	50	61	72	85	99	113	9
10	6	9	14	20	28	36	46	56	69	81	96	112	127	10
11	7	11	16	23	31	40	51	63	76	91	106	124	141	11
12	7	12	18	25	34	44	56	69	84	100	117	136	155	12
13	8	13	19	28	38	49	62	76	92	109	128	149	170	13
14	9	14	21	31	41	53	67	83	100	118	139	161	184	14
15	10	16	23	33	44	57	72	89	108	127	150	173	198	15
16	10	17	25	36	48	62	78	96	116	137	161	186	214	16
17	11	19	28	39	52	67	84	104	125	148	173	200	230	17
18	12	21	30	43	57	73	91	112	134	159	185	214	246	18
19	14	23	33	46	61	78	98	120	144	169	198	228	262	19
20	15	25	35	50	65	83	104	127	153	181	210	242	278	20
21	16	26	38	53	70	89	111	135	162	191	223	257	294	21
22	18	28	41	56	74	94	118	143	171	202	235	271	310	22
23	19	30	44	60	79	100	124	151	180	213	247	285	327	23
24	21	32	46	63	83	105	131	159	190	224	260	300	343	24
25	23	35	49	67	88	112	139	168	201	236	274	316	361	25
26	25	37	53	72	94	118	147	178	212	249	288	332	379	26
27	27	40	56	76	99	125	155	187	223	261	302	348	397	27
28	29	42	59	80	104	131	162	196	233	274	316	364	415	28
29	30	45	63	85	110	138	170	205	244	286	331	380	433	29
30	32	48	66	89	115	145	178	214	255	298	345	396	451	30
31	34	50	70	94	121	151	186	224	266	311	359	413	470	31
32	36	53	73	98	126	158	194	233	277	323	374	429	487	32

TABLE I—Continued.

Length in feet	DIAMETER IN INCHES													Length in feet
	17	18	19	20	21	22	23	24	25	26	27	28	29	
	BOARD FEET													
8	114	129	144	162	180	199	219	240	261	283	307	332	358	8
9	130	147	164	184	205	226	249	273	296	321	348	377	406	9
10	146	165	185	207	230	254	279	305	332	360	390	421	454	10
11	162	183	205	230	255	281	309	338	367	398	431	466	501	11
12	178	201	225	252	280	309	339	370	403	436	473	511	550	12
13	195	219	245	275	304	336	369	403	438	475	515	556	598	13
14	211	237	266	297	329	363	399	436	473	513	556	600	645	14
15	227	255	286	319	354	391	429	469	509	552	597	645	693	15
16	243	273	307	342	378	417	457	499	544	590	638	688	739	16
17	261	293	330	367	405	447	490	534	582	631	683	736	790	17
18	279	314	352	392	433	477	522	570	621	673	727	784	841	18
19	297	334	375	417	460	507	555	605	659	714	772	831	893	19
20	315	354	397	442	487	537	587	640	697	756	817	879	944	20
21	333	374	419	466	515	567	620	676	736	797	862	927	995	21
22	351	395	442	491	542	597	653	711	774	839	906	975	1045	22
23	369	415	464	516	570	627	685	746	813	880	951	1025	1095	23
24	387	435	487	541	597	657	718	782	851	922	996	1070	1150	24
25	407	457	512	568	627	689	753	820	892	966	1045	1120	1205	25
26	427	480	536	595	657	722	788	858	934	1010	1090	1175	1260	26
27	447	502	560	623	687	754	824	897	975	1060	1140	1225	1315	27
28	468	525	584	650	717	787	859	935	1020	1110	1185	1275	1365	28
29	488	547	608	678	747	819	894	974	1060	1160	1235	1330	1420	29
30	508	570	632	705	777	852	930	1010	1100	1205	1285	1380	1475	30
31	528	592	656	733	807	885	965	1050	1140	1255	1330	1430	1530	31
32	550	615	685	759	835	916	1000	1090	1180	1280	1375	1480	1585	32

TABLE I—Continued.

Length in feet	DIAMETER IN INCHES													Length feet
	30	31	32	33	34	35	36	37	38	39	40	41	42	
	BOARD FEET													
8	383	410	438	469	498	528	561	594	627	664	698	734	774	8
9	434	465	497	531	564	598	635	672	710	752	790	831	876	9
10	486	520	555	594	630	668	710	751	793	839	882	929	1130	10
11	537	574	614	656	696	739	783	829	876	926	973	1024	1080	11
12	588	629	673	718	762	808	858	908	959	1015	1065	1120	1180	12
13	639	684	721	781	828	879	932	986	1040	1100	1155	1215	1280	13
14	690	739	790	843	894	949	1005	1065	1125	1185	1250	1315	1380	14
15	742	792	848	905	960	1020	1080	1140	1210	1275	1340	1410	1485	15
16	793	848	907	968	1025	1090	1155	1220	1290	1360	1430	1505	1585	16
17	848	907	969	1035	1095	1165	1235	1305	1375	1455	1530	1610	1690	17
18	903	965	1030	1100	1165	1235	1310	1385	1465	1545	1625	1710	1800	18
19	957	1025	1095	1165	1235	1310	1390	1470	1550	1635	1720	1810	1905	19
20	1010	1085	1155	1230	1305	1385	1470	1550	1640	1730	1820	1915	2010	20
21	1065	1140	1220	1300	1375	1460	1545	1635	1725	1820	1915	2015	2120	21
22	1120	1200	1280	1365	1450	1535	1625	1720	1810	1910	2010	2115	2225	22
23	1175	1260	1345	1430	1520	1610	1705	1800	1900	2005	2110	2220	2330	23
24	1230	1320	1405	1495	1590	1685	1780	1885	1985	2095	2205	2320	2435	24
25	1290	1380	1470	1565	1660	1760	1865	1970	2080	2190	2305	2425	2550	25
26	1350	1440	1535	1635	1735	1840	1950	2060	2170	2285	2410	2530	2660	26
27	1405	1505	1605	1705	1810	1920	2030	2145	2260	2385	2510	2640	2770	27
28	1465	1565	1670	1776	1885	1995	2115	2230	2355	2480	2610	2745	2880	28
29	1525	1630	1735	1845	1960	2075	2195	2320	2445	2580	2715	2850	2995	29
30	1585	1690	1800	1915	2030	2155	2280	2405	2535	2675	2815	2960	3105	30
31	1640	1750	1865	1990	2105	2230	2365	2495	2630	2770	2915	3065	3215	31
32	1700	1815	1935	2055	2180	2310	2445	2580	2720	2870	3015	3170	3325	32

TABLE I—Continued.

Length in feet	DIAMETER IN INCHES													Length in feet
	43	44	45	46	47	48	49	50	51	52	53	54	55	
	BOARD FEET													
8	812	852	890	932	976	1020	1065	1110	1155	1200	1250	1300	1345	8
9	919	963	1005	1055	1105	1150	1200	1255	1305	1355	1410	1465	1520	9
10	1025	1075	1125	1175	1230	1285	1340	1395	1455	1510	1575	1635	1695	10
11	1130	1185	1240	1300	1360	1415	1480	1540	1605	1670	1735	1805	1870	11
12	1240	1295	1355	1420	1485	1550	1615	1685	1755	1825	1900	1970	2045	12
13	1345	1410	1475	1540	1625	1685	1755	1830	1905	1980	2060	2140	2170	13
14	1450	1520	1590	1665	1740	1815	1895	1975	2055	2140	2225	2310	2395	14
15	1560	1630	1705	1785	1865	1950	2035	2120	2205	2290	2385	2475	2570	15
16	1660	1740	1820	1905	1990	2080	2170	2260	2355	2445	2545	2645	2745	16
17	1775	1860	1945	2035	2000	2220	2315	2410	2515	2610	2715	2820	2925	17
18	1885	1975	2065	2160	2260	2360	2460	2560	2670	2770	2880	2995	3105	18
19	1995	2090	2190	2290	2390	2495	2605	2710	2825	2935	3050	3170	3285	19
20	2105	2210	2310	2420	2525	2635	2750	2860	2980	3095	3220	3345	3470	20
21	2220	2325	2430	2545	2655	2775	2895	3010	3135	3260	3380	3520	3650	21
22	2330	2440	2555	2670	2790	2910	3040	3160	3295	3420	3565	3695	3730	22
23	2440	2555	2675	2795	2920	3050	3180	3310	3450	3585	3725	3870	4010	23
24	2550	2675	2800	2925	3055	3190	3325	3460	3605	3745	3890	4045	4195	24
25	2670	2795	2925	3060	3195	3335	3475	3620	3770	3915	4065	4225	4380	25
26	2785	2920	3050	3190	3330	3480	3625	3775	3930	4080	4240	4405	4570	26
27	2900	3040	3180	3325	3470	3625	3775	3930	4090	4250	4415	4585	4755	27
28	3020	3160	3305	3460	3610	3765	3925	4085	4255	4415	4590	4765	4945	28
29	3135	3285	3435	3590	3745	3910	4075	4240	4415	4585	4765	4950	5135	29
30	3250	3405	3560	3725	3885	4055	4225	4400	4580	4755	4940	5130	5320	30
31	3365	3530	3690	3855	4025	4200	4375	4555	4740	4920	5115	5310	5510	31
32	3485	3650	3815	3990	4165	4345	4530	4710	4905	5090	5290	5495	5695	32

TABLE I—Continued.

Length in feet	DIAMETER IN INCHES													Length in feet
	56	57	58	59	60	61	62	63	64	65	66	67	68	
	BOARD FEET													
8	1400	1450	1505	1560	1615	1665	1725	1780	1840	1900	1960	2020	2080	8
9	1580	1640	1700	1760	1820	1880	1945	2010	2075	2145	2210	2280	2350	9
10	1760	1825	1895	1960	2030	2095	2170	2240	2315	2390	2465	2540	2610	10
11	1945	2015	2090	2165	2240	2315	2390	2470	2550	2635	2715	2800	2885	11
12	2125	2200	2285	2365	2445	2525	2615	2700	2790	2880	2970	3060	3150	12
13	2305	2390	2475	2570	2655	2745	2840	2930	3030	3125	3220	3320	3420	13
14	2485	2580	2675	2770	2865	2960	3060	3160	3265	3370	3475	3580	3690	14
15	2670	2765	2865	2975	3075	3175	3285	3390	3500	3615	3730	3840	3960	15
16	2850	2950	3060	3170	3280	3390	3500	3620	3735	3855	3975	4100	4220	16
17	3035	3145	3265	3380	3495	3615	3730	3860	3980	4110	4235	4370	4500	17
18	3225	3340	3465	3585	3710	3835	3960	4095	4225	4360	4495	4640	4775	18
19	3415	3535	3665	3795	3930	4060	4190	4335	4470	4615	4755	4905	5050	19
20	3600	3730	3870	4005	4145	4280	4420	4570	4715	4865	5015	5175	5325	20
21	3790	3925	4070	4210	4360	4505	4650	4810	4960	5120	5275	5445	5600	21
22	3975	4120	4275	4420	4575	4730	4880	5045	5205	5370	5535	5710	5880	22
23	4165	4315	4475	4630	4790	4950	5110	5280	5450	5625	5795	5980	6150	23
24	4355	4510	4675	4835	5005	5170	5340	5520	5695	5875	6055	6245	6430	24
25	4545	4710	4885	5050	5230	5400	5580	5765	5950	6135	6325	6520	6715	25
26	4740	4915	5090	5265	5450	5630	5815	6010	6200	6395	6590	6800	7000	26
27	4935	5115	5300	5480	5675	5860	6055	6255	6455	6655	6860	7075	7285	27
28	5130	5315	5510	5695	5895	6090	6290	6500	6705	6915	7130	7350	7570	28
29	5325	5520	5715	5915	6120	6320	6530	6745	6960	7175	7395	7625	7855	29
30	5520	5720	5915	6130	6345	6550	6765	6990	7210	7435	7665	7900	8140	30
31	5715	5925	6125	6345	6565	6780	7005	7235	7465	7695	7935	8180	8425	31
32	5910	6120	6345	6560	6785	7010	7240	7480	7715	7960	8200	8455	8705	32

TABLE I—Continued.

Length in feet	DIAMETER IN INCHES													Length in feet
	69	70	71	72	73	74	75	76	77	78	79	80	81	
	BOARD FEET													
8	2145	2210	2280	2340	2405	2475	2540	2610	2685	2755	2825	2900	2970	8
9	2420	2495	2515	2640	2705	2795	2865	2945	3030	3110	3185	3270	3355	9
10	2695	2780	2865	2940	3025	3115	3195	3285	3375	3460	3550	3645	3735	10
11	2975	3065	3155	3245	3335	3430	3520	3620	3720	3815	3910	4015	4115	11
12	3250	3350	3450	3545	3645	3745	3845	3955	4065	4165	4275	4385	4500	12
13	3525	3630	3740	3845	3955	4065	4170	4290	4410	4520	4635	4755	4880	13
14	3800	3915	4035	4145	4265	4385	4500	4620	4755	4875	5000	5130	5260	14
15	4075	4200	4325	4445	4570	4700	4825	4960	5100	5225	5360	5500	5640	15
16	4350	4480	4610	4745	4880	5020	5150	5290	5440	5580	5720	5870	6020	16
17	4635	4775	4915	5055	5200	5350	5490	5635	5795	5945	6090	6255	6415	17
18	4920	5065	5215	5365	5520	5675	5825	5980	6150	6305	6465	6635	6805	18
19	5205	5360	5515	5675	5835	6000	6160	6325	6500	6670	6835	7015	7195	19
20	5490	5650	5815	5985	6150	6325	6495	6670	6855	7030	7205	7400	7585	20
21	5775	5945	6115	6295	6470	6655	6830	7010	7205	7395	7575	7780	7975	21
22	6060	6235	6415	6605	6790	6980	7165	7355	7560	7755	7950	8160	8370	22
23	6345	6525	6715	6910	7105	7305	7500	7700	7910	8115	8320	8540	8755	23
24	6630	6820	7020	7225	7425	7635	7840	8045	8265	8480	8690	8925	9150	24
25	6925	7125	7330	7540	7750	7970	8180	8400	8625	8855	9075	9315	9550	25
26	7215	7425	7640	7860	8075	8305	8525	8755	8990	9225	9455	9705	9950	26
27	7510	7725	7950	8180	8400	8640	8870	9105	9350	9595	9835	10100	10350	27
28	7800	8025	8260	8495	8730	8975	9215	9460	9715	9970	10200	10500	10750	28
29	8095	8325	8570	8815	9055	9310	9560	9810	10100	10350	10600	10900	11150	29
30	8385	8630	8880	9130	9380	9645	9905	10150	10450	10700	11000	11250	11550	30
31	8680	8930	9190	9450	9710	9985	10250	10500	10800	11100	11350	11650	11950	31
32	8965	9230	9495	9770	10050	10300	10600	10900	11150	11454	11750	12050	12355	32

TABLE I—Continued.

Length in feet	DIAMETER IN INCHES													Length in feet
	82	83	84	85	86	87	88	89	90	91	92	93	94	
	BOARD FEET													
8	3050	3130	3205	3285	3365	3445	3525	3605	3690	3775	3855	3940	4030	8
9	3445	3530	3615	3705	3795	3885	3975	4070	4160	4255	4350	4445	4545	9
10	3835	3930	4025	6125	4225	4325	4425	4530	4630	4735	4845	4950	5060	10
11	4225	4330	4435	4545	4655	4765	4880	4985	5105	5220	5335	5455	5570	11
12	4615	4730	4850	4965	5085	5205	5325	5450	5575	5700	5830	5955	6090	12
13	5010	5135	5230	5390	5515	5650	5775	5905	6050	6185	6325	6460	6600	13
14	5400	5535	5670	5810	5950	6085	6230	6370	6520	6665	6815	6965	7120	14
15	5790	5935	6080	6230	6375	6530	6680	6835	6990	7150	7305	7470	7630	15
16	6180	6335	6490	6650	6810	6965	7130	7295	7460	7630	7800	7970	8145	16
17	6580	6745	6910	7080	7250	7420	7590	7765	7945	8125	8305	8485	8670	17
18	6980	7155	7330	7510	7690	7870	8055	8235	8425	8615	8810	9000	9200	18
19	7380	7565	7755	7940	8130	8320	8515	8710	8910	9110	9310	9515	9725	19
20	7785	7975	8170	8370	8570	8770	8975	9180	9390	9600	9815	10050	10250	20
21	8190	8385	8595	8805	9015	9220	9435	9650	9870	10100	10300	10550	10800	21
22	8590	8800	9015	9235	9455	9675	9900	10100	10350	10600	10850	11050	11300	22
23	8985	9210	9435	9665	9895	10120	10350	10600	10850	11100	11300	11550	11850	23
24	9385	9620	9855	10100	10350	10520	10800	11050	11300	11600	11850	12100	12350	24
25	9795	10050	10300	10550	10800	11050	11300	11550	11800	12100	12350	12600	12900	25
26	10200	10450	10700	10950	11250	11500	11750	12050	12300	12600	12850	13150	13400	26
27	10600	10900	11150	11400	11700	11950	12250	12500	12800	13100	13350	13650	13950	27
28	11050	11300	11600	11850	12150	12400	12700	13000	13300	13600	13900	14200	14500	28
29	11450	11700	12000	12300	12600	12900	13200	13500	13800	14100	14400	14700	15050	29
30	11850	12150	12450	12750	13050	13350	13650	13950	14300	14600	14900	15250	15550	30
31	12250	12550	12850	13200	13500	13800	14100	14450	14800	15100	15450	15750	16100	31
32	12650	13000	13300	13600	13950	14250	14600	14950	15300	15600	15950	16300	16650	32

TABLE I—Continued.

Length in feet	DIAMETER IN INCHES													Length in feet
	95	96	97	98	99	100	101	102	103	104	105	106	107	
	BOARD FEET													
8	4115	4205	4295	4395	4480	4570	4665	4755	4855	4050	5045	5145	5240	8
9	4640	4740	4840	4955	5050	5155	5260	5365	5470	5580	5690	5800	5910	9
10	5170	5280	5390	5515	5620	5740	5855	5970	6090	6210	6330	6455	6575	10
11	5690	5800	5940	6075	6190	6320	6445	6580	6705	6840	6975	7110	7245	11
12	6220	6350	6495	6635	6765	6900	7040	7185	7330	7470	7680	7765	7915	12
13	6745	6885	7035	7195	7335	7480	7640	7795	7945	8095	8260	8420	8580	13
14	7270	7425	7590	7755	7905	8070	8235	8400	8565	8730	8900	9075	9245	14
15	7800	7965	8140	8315	8480	8650	8830	9005	9185	9360	9545	9730	9910	15
16	8320	8500	8680	8865	9045	9235	9420	9310	9800	9995	10200	10400	10600	16
17	8860	9050	9240	9435	9630	9830	10050	10250	10450	10650	10850	11050	11250	17
18	9395	9600	9800	10000	10210	10400	10650	10850	11050	11300	11500	11700	11950	18
19	9930	10150	10350	10600	10800	11000	11250	11450	11700	11900	12150	12400	12650	19
20	10450	10700	10900	11150	11400	11600	11850	12100	12300	12550	12800	13050	13300	20
21	11000	11250	11500	11700	11950	12200	12450	12700	12950	13200	13450	13750	14000	21
22	11550	11800	12050	12300	12550	12800	13050	13300	13600	13850	14100	14400	14650	22
23	12100	12350	12600	12850	13150	13400	13650	13950	14200	14500	14800	15250	15350	23
24	12600	12900	13150	13450	13700	14000	14250	14550	14850	15150	15450	15750	16050	24
25	13150	13450	13750	14000	14300	14600	14900	15200	15500	15800	16100	16400	16700	25
26	13700	14000	14300	14600	14900	15200	15500	15800	16150	16450	16750	17100	17400	26
27	14250	14550	14850	15200	15500	15800	16150	16450	16750	17100	17450	17750	18100	27
28	14800	15150	15450	15750	16100	16400	16750	17100	17400	17750	18100	18450	18800	28
29	15350	15700	16000	16350	16700	17050	17350	17700	18000	18400	18750	19150	19500	29
30	15900	16250	16600	16950	17300	17650	18000	18350	18700	19050	19450	19800	20200	30
31	16450	16800	17150	17500	17850	18250	18600	18950	19350	19700	20100	20500	20900	31
32	17000	17350	17750	18100	18450	18850	19200	19600	20000	20400	20750	21150	21550	32

TABLE I—Continued.

Length in feet	DIAMETER IN INCHES													Length in feet
	108	109	110	111	112	113	114	115	116	117	118	119	120	
	BOARD FEET.													
8	5345	5445	5545	5650	5750	5860	5965	6070	6175	6285	6395	6505	6615	8
9	6025	6140	6250	6370	6485	6605	6700	6840	6930	7080	7205	7330	7460	9
10	6705	6830	6955	7090	7215	7350	7500	7615	7745	7880	8025	8160	8300	10
11	7385	7520	7660	7810	7945	8095	8250	8385	8530	8675	8835	8985	9140	11
12	8065	8220	8370	8525	8680	8840	9000	9155	9320	9480	9645	9815	9980	12
13	8745	8910	9075	9250	9415	9585	9750	9930	10100	10250	10450	10645	10800	13
14	9425	9600	9780	9970	10150	10350	10500	10700	10900	11050	11250	11450	11650	14
15	10100	10300	10500	10700	10900	11100	11300	11500	11650	11850	12100	12300	12500	15
16	10800	11000	11200	11400	11600	11800	12050	12250	12450	12700	12900	13100	13350	16
17	11500	11700	11900	12150	12350	12600	12800	13050	13250	13500	13700	13950	14200	17
18	12150	12400	12650	12850	13100	13350	13550	13800	14050	14300	14550	14800	15050	18
19	12850	13100	13350	13600	13850	14000	14350	14600	14850	15100	15350	15650	15900	19
20	13550	13800	14050	14350	14600	14850	15100	15400	15650	15950	16200	16500	16750	20
21	14250	14500	14800	15050	15350	15600	15900	16150	16450	16750	17000	17300	17600	21
22	14950	15250	15500	15800	16100	16350	16650	16950	17250	17550	17850	18150	18450	22
23	15650	15900	16250	16550	16850	17100	17450	17750	18050	18350	18650	19000	19300	23
24	16350	16650	16950	17250	17550	17900	18200	18550	18850	19200	19500	19850	20200	24
25	17050	17350	17650	18000	18350	18650	19000	19350	19650	20000	20350	20700	21050	25
26	17750	18050	18400	18750	19100	19450	19800	20150	20500	20850	21200	21550	21950	26
27	18450	18800	19150	19500	19850	20200	20550	20900	21300	21650	22050	22400	22800	27
28	19150	19500	19850	20250	20600	21000	21350	21700	22100	22500	22850	23250	23650	28
29	19850	20250	20600	21000	21350	21750	22150	22500	22900	23300	23700	24100	24550	29
30	20550	20950	21350	21750	22100	22500	22900	23300	23750	24150	24550	25000	25400	30
31	21250	21650	22050	22500	22900	23300	23700	24100	24550	24950	25400	25850	26250	31
32	22000	22400	22800	23200	23650	24050	24500	24900	25350	25800	26250	26700	27150	32

A COMPARISON OF THREE DIFFERENT TYPES OF LOG RULES.

There are three distinct types of log rules now in general use. They are as follows: (a) Rules with a waste allowance varying directly as the barked area of the log and the volume of the log after the barked area allowance is made. (b) Rules with a waste allowance varying directly as the total volume of the log alone. (c) Rules with a waste allowance varying directly as the total volume of the log plus a constant.

When $D =$ diameter at small end inside bark in inches.
When $L =$ length of log in feet.
When $a =$ constant (in inches).
When $\pi = 3.1416$.
When $c =$ constant with limits of 0 and 1.
When B. M. = volume in board feet of manufactured product,

the three types may be expressed by these formulæ:

(a) $$(1 - c)\,\frac{\pi (D - a)^2}{4 \times 12} L = \text{B.M.}$$

(b) $$(1 - c)\,\frac{\pi D^2}{4 \times 12} L = \text{B.M.}$$

(c) $$\left[(1 - c)\,\frac{\pi D^2}{4 \times 12} - b\right] L = \text{B.M.}$$

NOTE: The above formulæ are special cases of

$$\left[(1 - c)\,\frac{\pi (D - a)^2}{4 \times 12} - b\right] L = \text{B.M.}$$

In formula (a) the constant b equals zero, and the constant a has a positive value. Therefore, the curve $(1 - c)\,\frac{\pi D^2}{4 \times 12} L$ has been moved in a horizontal direction a units to the right of the origin.

In (b), $a=0$, and $b=0$, or the curve maintains its normal position.

In (c), $a=0$, and b has a positive value, or the curve has been moved in a vertical direction b units.

None of the log rules analyzed had values for both a and b such that one of them could not be easily eliminated. The Universal Log Rule, for instance, reduces to the following formula:

$$\left[(1 - .20)\,\frac{\pi (D - 1.591)^2}{4 \times 12} - .1325\right] L = \text{B.M.}$$

The constant $b=.1325$ is so small that its effect upon the log rule is negligible. $(1 - .20)\,\frac{\pi (D - 1.6)^2}{4 \times 12} L = \text{B.M.}$ gives values for this rule within 2 board feet, and is the formula listed below.

The following is a comparison of log rules which may be expressed in the form:

$$(1 - c)\frac{\pi(D - a)^2}{4 \times 12}L = \text{B.M.}$$

NOTE: The constant c is the fractional part of the log becoming sawdust after an allowance of a inches from the diameter has been made for slabs. It can be expressed in per cent by multiplying by 100, or moving the decimal point two places to the right. $(1 - c)$ in like manner is the fractional part allowed for the manufactured product.

Champlain:

$$(1 - .20)\frac{\pi(D - .8)^2}{4 \times 12}L = \text{B.M.}$$

Boughman Rotary Saw: (Original values slightly erratic)

$$(1 - .19)\frac{\pi(D - .87)^2}{4 \times 12}L = \text{B.M.}$$

Boughman Band Saw: (Original values slightly erratic)

$$(1 - .10)\frac{\pi(D - 1)^2}{4 \times 12}L = \text{B.M.}$$

Wilson: (Original values slightly erratic)

$$(1 - .193)\frac{\pi(D - 1)^2}{4 \times 12}L = \text{B.M}$$

Carey: (Original values slightly erratic)

$$(1 - .193)\frac{\pi(D - 1)^2}{4 \times 12}L = \text{B.M.}$$

Baxter:

$$(1 - .338)\frac{\pi(D - 1)^2}{4 \times 12}L = \text{B.M.}$$

Click: (Original values slightly erratic)

$$(1 - .236)\frac{\pi(D - 1.25)^2}{4 \times 12}L = \text{B.M.}$$

British Columbia:

$$(1-.273)\frac{\pi(D-1.5)^2}{4\times 12}L=\text{B.M.}$$

Universal:

$$(1-.20)\frac{\pi(D-1.6)^2}{4\times 12}L=\text{B.M.}$$

International:

$$(1-.16)\frac{\pi(D-1.62)^2}{4\times 12}L=\text{B.M.}$$

(Applied to 4′ sections with taper allowance of 1″ in 8′, and constructed for $\frac{1}{8}$″ saw-kerf.)

Preston:

$$(1-.20)\frac{\pi(D-1.75)^2}{4\times 12}L=\text{B.M.}\quad\text{(Small logs)}$$

$$(1-.20)\frac{\pi(D-1.5)^2}{4\times 12}L=\text{B.M.}\quad\text{(Large logs)}$$

Doyle:

$$(1-.045)\frac{\pi(D-4)^2}{4\times 12}L=\text{B.M.}$$

McKenzie:

$$\left[1-\frac{k(w+t+k)}{(w+k)(t+k)}\right]\frac{\pi(D-a)^2}{4\times 12}L+C=\text{B.M.}$$

Where k = saw-kerf in inches.
Where t = average thickness of lumber sawed, in inches.
Where w = average width of lumber sawed, in inches.
Where a = constant.
Where C = constant included to compensate for excessive taper in small logs.

To be applied to 8′ sections with taper allowance of e'' in f'.

It will be observed that of the above rules the Doyle and the Baxter are the two extremes. The Doyle rule has an enormous slab allowance with extremely small allowance for sawdust, (4.5%); where the Baxter rule has a small slab allowance and a very large allowance for sawdust, (33.8%).

Log rules of this form are correct in principle, and can be adapted to conditions existing at different mills, and to the character of the timber in different localities. The sawdust allowance, however, should not be fixed, but should depend upon the width of saw-kerf and the average dimensions of the lumber. The slab allowance should also be flexible, and should be determined by the timber to be sawed. Allowances for taper, excessive taper in small logs, shrinkage, etc., can be applied when making up a table based upon

$$(1 - c)\frac{\pi (D - a)^2}{4 \times 12} L = \text{B.M.}$$

This type of log rule can be represented diagramatically by drawing concentric circles of diameters D and $(D - a)$ respectively. The difference between the two rings will represent slab allowance. Draw a sector of the small circle with angle equal to $c \times 360°$. This will represent the sawdust allowance.

The following is a comparison of log rules which may be expressed in the form:

$$(1 - c)\frac{\pi D^2}{4 \times 12} L = \text{B.M.}$$

Constantine:

$$(1 - 0)\frac{\pi D^2}{4 \times 12} L = \text{B.M.}$$

Saco River: (Original values slightly erratic)

$$(1 - .276)\frac{\pi D^2}{4 \times 12} L = \text{B.M.}$$

Derby: (Original values slightly erratic)

$$(1 - .279)\frac{\pi D^2}{4 \times 12} L = \text{B.M.}$$

Square of Three-quarters:

$$(1 - .283)\frac{\pi D^2}{4 \times 12} L = \text{B.M.}$$

Partridge: (Original values slighty erratic)

$$(1 - .312)\frac{\pi D^2}{4 \times 12} L = \text{B.M.}$$

Vermont:

$$(1 - .363)\frac{\pi D^2}{4 \times 12}L = \text{B.M.}$$

NOTE: This rule gives the solid contents in board feet of the largest square timber contained in a log D'' in diameter inside bark at small end, and when divided by 12, becomes the formula for the Inscribed Square Rule, which actually gives the cubic contents of the largest square timber that can be sawed from a log of known length and diameter.

Stillwell: (Original values erratic)

$$(1 - .368)\frac{\pi D^2}{4 \times 12}L = \text{B.M.}$$

Ake:

$$(1 - .376)\frac{\pi D^2}{4 \times 12}L = \text{B.M.}$$

Square of Two-Thirds:

$$(1 - .435)\frac{\pi D^2}{4 \times 12}L = \text{B.M.}$$

NOTE: This formula, when divided by 12, is supposed to give, but does not give, the number of cubic feet of square timber that can be sawed from a log D'' in diameter at middle point inside bark. After the division by 12 is made, it is called the Two-Thirds Rule.

Orange River:

$$(1 - .491)\frac{\pi D^2}{4 \times 12}L = \text{B.M.}$$

Cumberland River:

$$(1 - .548)\frac{\pi D^2}{4 \times 12}L = \text{B.M.}$$

It is obvious that the Constantine rule has no allowance for either slabs or sawdust, and that all log rules which can be expressed in this form have a total waste allowance which is directly proportional to the total volume of the log, (taper not taken into consideration). The two extremes are the Constantine and the Cumberland River. The former with no allowance for waste whatever and the latter with an allowance of 54.8%.

There can not exist for different sized logs a constant ratio between volume sawed out at mill and volume in board feet as shown by a log rule of the above form. The principle is incorrect.

$(1 - c)\frac{\pi D^2}{4 \times 12}L =$ B.M. can be represented diagramatically by drawing a circle diameter D and then a sector of that circle with angle at center equal to $c \times 360°$. The area of the sector will represent the total waste allowance and the remaining area the lumber product.

The following is a comparison of log rules which may be expressed in the form:

$$\left[(1-c)\frac{\pi D^2}{4\times 12}-b\right]L=\text{B.M.}$$

Bangor: (Original values slightly erratic)

$$\left[(1-.258)\frac{\pi D^2}{4\times 12}-.5\right]L=\text{B.M.}$$

Boynton: (Original values erratic)

$$\left[(1-.350)\frac{\pi D^2}{4\times 12}-.67\right]L=\text{B.M.}$$

Parsons: (Original values erratic)

$$\left[(1-.246)\frac{\pi D^2}{4\times 12}-1\right]L=\text{B.M.}$$

Warner: (Original values erratic)

$$\left[(1-.466)\frac{\pi D^2}{4\times 12}-1\right]L=\text{B.M.}$$

Spaulding: (Original values slightly erratic)

$$\left[(1-.266)\frac{\pi D^2}{4\times 12}-2\right]L=\text{B.M.}$$

Hannah: (Original values very erratic)

$$\left[(1-.266)\frac{\pi D^2}{4\times 12}-2\right]L=\text{B.M.}$$

Applies approximately to logs from 12″ to 42″ in diameter. This rule is very poorly constructed.

Wilcox: (Original values erratic)

$$\left[(1-.340)\frac{\pi D^2}{4\times 12}-2\right]L=\text{B.M.}$$

Finch and Apgar: (Original values very erratic)

$$\left[(1-.280)\frac{\pi D^2}{4\times 12}-2.5\right]L=\text{B.M.}$$

Ropp:

$$\left[(1-.236)\frac{\pi D^2}{4\times 12}-3\right]L=\text{B.M.}$$

Scribner: (Original values very erratic)

$$\left[(1-.266)\frac{\pi D^2}{4\times 12}-3\right]L=\text{B.M.}$$

Applies approximately to logs from 14″ to 75″, inclusive, in diameter. This rule is very poorly constructed.

Favorite: (Original values erratic)

$$\left[(1-.285)\frac{\pi D^2}{4\times 12}-3\right]L=\text{B.M.}$$

Maine: (Original values slightly erratic)

$$\left[(1-.222)\frac{\pi D^2}{4\times 12}-.67\right]L=\text{B.M.}$$

(For small logs, 6″ to 15″, inclusive.)

$$\left[(1-.222)\frac{\pi D^2}{4\times 12}-2\right]L=\text{B.M.}$$

(For logs 16″ to 48″, inclusive.)

Herring: (Original values slightly erratic)

$$\left[(1-.392)\frac{\pi D^2}{4\times 12}-1\right]L=\text{B.M.}$$

(Small logs up to 30″.)

$$\left[(1-.313)\frac{\pi D^2}{4\times 12}-5.5\right]L=\text{B.M.}$$

(For logs from 30″ to 42″, inclusive.)

Dusenbury: (Original values slightly erratic)
Practically the same as the Herring Log Rule.

Rules of this form will usually give a large per cent of mill overrun for small logs, due to the presence of the constant b. Intermediate logs will run below, hold up the scale or overrun, all depending upon the value of c in the rule used and the width of the saw-kerf. The effect of the constant b becomes small for intermediate sized logs, and is practically negligible for large ones. Large logs will run higher in per cent of mill overrun than the intermediate, since the slab allowance in this type of log rule increases directly as the volume of the log plus a constant. The principle is incorrect.

$\left[(1-c)\dfrac{\pi D^2}{4 \times 12} - b\right] L = \text{B.M.}$ can be represented diagramatically by drawing two concentric circles, the larger one with diameter D and the smaller one with diameter sufficient to allow for b board feet; then drawing a sector forming an angle of $c \times 360°$ at the center. The area of the sector and the small circle will represent the waste allowance for slabs, sawdust, etc., while the remaining area will be the lumber product.

MISCELLANEOUS LOG RULES.

The Chapin, Northwestern, White and Ballon log rules have no definite underlying principles.

The Drew and the Forty-five were found to be of the form

$$\left[1 - (c - eD)\right] \frac{\pi D^2}{4 \times 12} L = \text{B.M.}$$

Where $c =$ constant less than 1 and greater than 0.

Where $e =$ constant much smaller than c and greater than 0.

Their formulæ are as follows:

The Forty-five rule:

$$\left[1 - (.496 - .00763 D)\right] \frac{\pi D^2}{4 \times 12} L = \text{B.M.}$$

The Drew Rule:

$$\left[1 - (.450 - .003 D)\right] \frac{\pi D^2}{4 \times 12} L = \text{B.M.}$$

In these rules the allowance for total wastage when expressed in per cent of the total contents of the log, taper not considered, decreases uniformly as the diameter increases. When $eD = c$, there is no allowance for wastage whatever. The Forty-five Log Rule allows for no wastage in logs 65″ in diameter and shows more volume for logs over 65″ than they actually contain. The Drew rule also shows a uniformly decreasing per cent of wastage, and for logs 150″ in diameter the waste allowance becomes zero. The principle of these rules is absolutely incorrect.

LOG RULES BASED ON STANDARDS.

Any log rule, constructed to show volume in board feet of lumber contained in logs of various lengths and diameters, which is based upon definite principles, may be reduced to what is called a standard log rule. The only difference between the ordinary log rule and its unlimited number of standards is in the unit of measure. A log of any specified dimensions may be chosen as the unit of measure, and so long as the underlying principles of both the standard and the rule expressing values in board feet are the same, there will always exist a definite relation between them and the one may be expressed in terms of the other by multiplying by a constant.

When $d =$ Diameter in inches of the standard log and
$l =$ Length in feet of the standard log,

log rules of the form $(1 - c)\dfrac{\pi (D - a)^2}{4 \times 12} L = \text{B.M.}$

$$\text{become } \frac{(D - a)^2 L}{(d - a)^2 l} = V, \text{ in standards.}$$

Log rules of the form $(1 - c)\dfrac{\pi D^2}{4 \times 12} L = \text{B.M.}$

$$\text{become } \frac{D^2 L}{d^2 l} = V, \text{ in standards.}$$

Log rules of the form $\left[(1 - c)\dfrac{\pi D^2}{4 \times 12} - b\right] L = \text{B.M.}$

$$\text{become } \frac{(D^2 - s) L}{(d^2 - s) l} = V, \text{ in standards.}$$

All standard log rules now in use are based upon $\dfrac{D^2 L}{d^2 l} = \text{Vol.}$, in standards. Therefore, any one of them may be reduced to the form $(1 - c)\dfrac{\pi D^2}{4 \times 12} L = \text{B.M.}$, since $\dfrac{D^2 L}{d^2 l} \times \text{Const.} = (l - c)\dfrac{\pi D^2}{4 \times 12} L$. Furthermore, it is evident that all standard rules of the same form bear a constant relation the one to the other, and any number of units of a certain standard rule may be reduced to units of any other standard of the same form by multiplying by the proper constant. For example, the Nineteen Inch Standard Rule, $\left(\dfrac{D^2 L}{19^2 \times 13} = V, \text{ in standards}\right)$, may be applied to a large number of logs of different sizes, and the aggregate scale of these logs then given in 19″ standards, may be reduced to Blodgett, cube standards, etc., or to any of the following log rules expressing results in board feet: Constantine, Saco River, Derby, Square of Three-quarters, Partridge, Vermont, Stillwell, Ake, Square of Two-thirds, Orange River, or Cumberland River, by multiplying the aggregate by the proper constant. The result in every case will be precisely the same as though the logs were scaled separately by each of the rules. If, however, it is desired to reduce the aggregate scale of these logs now expressed in standards or in board feet, as the case may be, to board feet as shown by the Doyle Log Rule, for instance, the problem is impossible. There is no way of making the reduction. The logs will have to be scaled in accordance with the principles of the Doyle Log Rule in order to get such results. If only a single log were in question instead of a number of different sizes, it would be very easy to make such a reduction, but since there is no common ratio existing between the Doyle Log Rule (also other rules of that form) and the Nineteen Inch Standard (and others of its form) for logs of all sizes, the reduction can not be applied to more than one log or set of logs of equal diameters.

It is folly to compare results obtained by two logs rules of different forms as applied to logs of various sizes. It is evident that a comparison of the formulæ of such rules would reveal a great deal more. Values shown by log rules of different forms are not comparable, since their underlying principles are different. Any comparison made of such values only lead to confusion and really do more harm than good.

The following will illustrate how the Nineteen Inch Standard Rule may be reduced to other standards and also to any log rule giving values in board feet which is of the same form:

Given: The Nineteen Inch Standard Rule $\frac{D^2 L}{19^2 \times 13} = V$, in 19″ standards, and given: The Blodgett rule $\frac{D^2}{16^2} L = V$, in Blodgett standards, to find the common reducing factor c:

$$\frac{D^2 L}{19^2 \times 13} \times c = \frac{D^2 L}{16^2}$$

$$\frac{c}{19^2 \times 13} = \frac{1}{16^2}$$

$$c = \frac{19^2 \times 13}{16^2} = 18.33$$

Therefore, if a log or any number of logs of different sizes have been scaled by the Nineteen Inch Standard Rule, the results may be expressed in Blodgett standards by multiplying by 18.33, which is the number of Blodgett standards contained in a Nineteen Inch standard. The ratio holds constant regardless of the size of the logs.

In like manner, the reducing factors for all other standard rules may be obtained.

Given: The Nineteen Inch Standard Rule $\frac{D^2 L}{19^2 \times 13} = V$, in standards, and the Vermont rule $(1 - .363) \frac{\pi D^2}{4 \times 12} L =$ B.M. in board feet.

To find how many board feet as shown by the Vermont rule are equivalent to a standard of the Nineteen Inch rule:

$$(1-.363)\frac{\pi\,19^2}{48}\times 13=195.5$$

Therefore, 195.5 board feet as shown by the Vermont rule equals one standard of the Ninteen Inch Standard Rule. This relation holds for all sized logs. In like manner, reducing factors for the Constantine, Saco River, Derby, Square of Three-quarters, Partridge, Stillwell, Ake, Square of Two-thirds, Orange River and Cumberland River rules may be obtained. All rules of the above form have definite reducing factors which apply to all logs, regardless of size, and to any aggregate scale representing any number of logs.

Given: The Nineteen Inch Standard Rule $\frac{D^2\,L}{19^2\times 13}=V$, in standards, to find a log rule equivalent to it when one standard $=200$ board feet:

$$(1-c)\,\frac{\pi\,19^2}{4\times 12}\times 13=200$$

$$1-c=\frac{200\times 48}{\pi\times 19^2\times 13}=.650$$

$$c=.350$$

Therefore: $(1-.350)\frac{\pi\,D^2}{4\times 12}L=\text{B.M.}$ is an equivalent rule for the Nineteen Inch Standard when a standard unit is equal to 200 board feet. In like manner equivalent rules for other standard rules may be obtained when the value of the unit is given in board feet.

For instance, the Blodgett rule allows 10 board feet for the equivalent of one standard, and the resulting rule which is equivalent to the Bodgett under these conditions is

$$(1-.405)\frac{\pi\,D^2}{4\times 12}L=\text{B.M.}$$

$(1-.423)\frac{\pi\,D^2}{4\times 12}L=\text{B.M.}$ is the equivalent for the cube rule when its standard unit $=12$ board feet.

It must be borne in mind that log rules of the form

$$(1-c)\frac{\pi\,D^2}{4\times 12}L=\text{B.M.}$$

are very poor rules for measuring the number of board feet of lumber that can be sawed from logs of different sizes, and that the three distinct types of rules discussed under the heading "A Comparison of Three Different Types of Log Rules" can have no common reducing factor for logs of different sizes, since the underlying principles are not the same. In the case of the standard rule based upon $\frac{D^2 L}{d^2 l} = V$, V is directly proportional to the square of the diameter of the log and also directly proportional to its length, whereas a log rule based upon correct principles has the volume in board feet vary directly as the diameter minus a constant squared, and directly as the length, with a taper correction applied to at least 8′ sections.

Standard log rules based upon $\frac{D^2 L}{d^2 l} = V$ are, however, excellent rules where a measurement proportional to the total contents of the log is desired. Such measures are applicable to logs which are to be made into pulp or whenever the total contents of the log is to be used. These rules do not take taper into consideration. They can be reduced to cubic feet by multiplying by a constant.

THE TRANSFORMATION OF VOLUME TABLES BASED UPON A GIVEN LOG RULE TO VOLUME TABLES BASED UPON OTHER RULES.

Volume tables constructed to show the number of board feet contained in trees of different merchantable lengths and diameters breasthigh, and based upon a log rule of the form

$$(1-c)\frac{\pi(D-a)^2}{4\times 12}L=\text{B.M.}$$

can be transformed to tables based upon other rules of the same form where the value of the constant a is the same. If the value of a is different in the rule to which the values are to be reduced, there is no way of accomplishing the transformation. For example, tables based upon the Baxter rule can be transformed to tables based upon the Boughman Band Saw rule by dividing each value in the former table by (1 — .338) and multiplying by (1 — .10). But tables based upon the Baxter rule cannot be transformed to ones based upon the Doyle rule, or on any other rule of that form where a is not the same as in the Baxter rule, or to forms where a does not enter, unless the average diameter of all portions of the bole is known thus making it possible to find the value of D for all logs in the tree.

Volume tables based upon rules of the form $(1-c)\frac{\pi D^2}{4\times 12}L=\text{B.M.}$ and also upon the form $\left[(1-c)\frac{\pi D^2}{4\times 12}-b\right]L=\text{B.M.}$ can be easily transformed from the one to the other. For example, a volume table based upon the Spaulding Log Rule, showing the average volume in board feet of trees of different diameters breasthigh and merchantable lengths can be transformed to a table based upon the Ropp rule by adding twice the average merchantable length shown in the table to each average value, and then dividing by (1 — .266) and multiplying by (1 — .236) and subtracting from each value thus obtained three times the merchantable length. The resulting table will then be based upon the Ropp rule, and the values therein will be the same as though the Ropp rule had been used for scaling the individual logs instead of the Spaulding rule. In like manner, any volume table based upon a log rule of the form $\left[(1-c)\frac{\pi D^2}{4\times 12}-b\right]L=\text{B.M.}$, can be transformed to a volume table based upon any other log rule of that form.

Again, a volume table based upon a log rule of the above form can be transformed to a volume table based upon any log rule of the form $(1-c)\frac{\pi D^2}{4\times 12}L=\text{B.M.}$ by adding to each value in the table $b\times$ the merchantable length, and then dividing by $(1-c)$ of the log rule upon which it is based and multiplying by the value of $(1-c)$ of the log rule to which the transformation is to be made. For example: A volume table based upon the Spaulding Log Rule showing average volume in board feet of trees of different diameters breasthigh and merchantable lengths can be transformed to a table based upon the Vermont rule by adding twice the average merchantable length to each of the values shown in the table, and then dividing the values thus obtained by (1 — .266) and multiplying by (1 — .363). The resulting table will then be based upon the Vermont rule. Should it be desirable to further transform the table to values in cubic feet of the Inscribed Square rule, divide all values by 12. This last reduction will show the volume in cubic feet of the square timbers that can be sawed from trees of different merchantable lengths and diameters breasthigh.

The total number of cubic feet inside bark contained in logs of trees measured for the original volume table based on the Spaulding Log Rule can be obtained by adding twice the average merchantable length to each value in the table and then dividing by (1 — .266) and dividing by 12. This reduction gives the volume in cubic feet of the total logs in each tree, without the taper of the various logs originally measured being taken into consideration.

To recapitulate: All volume tables based upon

$$(1-c)\frac{\pi\,(D-a)^2}{4\times 12}L=\text{B.M.}$$

can be reduced to any other table based upon the same form of log rule where the constant *a* is the same as in the rule originally used in compiling the table.

All volume tables based upon rules of the form

$$(1-c)\frac{\pi\,D^2}{4\times 12}L=\text{B.M., or }\left[(1-c)\frac{\pi\,D^2}{4\times 12}-b\right]L=\text{B.M.}$$

can be reduced or transformed to volume tables based upon any log rule of either of these forms, and in all cases the resulting tables will be the same as though the individual rules had been applied to the original data.

Any volume table based upon one of the following rules can be transformed to a volume table based upon any of the other rules here given: Constantine, Saco River, Derby, Square of Three-fourths, Partridge, Vermont, Inscribed Square (which is the Vermont rule divided by 12), Sillwell, Ake, Square of Two-thirds, Two-thirds rule (which is the Square of Two-thirds Rule divided by twelve), Orange River, Cumberland River, Bangor, Boynton, Parsons, Warner, Spaulding, Wilcox, Ropp, Favorite, Nineteen Inch Standard, New Hampshire (or Blodgett), the Cube Rule, Twenty-two Inch Standard, Twenty-four Inch Standard, Seventeen Inch Rule.

NOTE: The Hannah, Finch and Apgar, and Scribner rules have been omitted in the above list since their original values appear too erratic to be included. The Maine, Herring and Dusenbury also have been omitted, since each of these rules have separate formulæ for small and large logs.

In like manner any volume table based upon

$$(1-c)\frac{\pi\,(D-a)^2}{4\times 12}L=\text{B.M.}$$

can be transformed to other volume tables of the same form, provided the constant *a* is the same in rules under consideration.

The following tables illustrate how the transformations described above may be made:

TABLE 2. Average volume in board feet, as shown by the Spaulding Log Rule, contained in merchantable portion of immature western yellow pine trees of different merchantable lengths and diameters breast high.

TABLE 2.

Diameter breast-high in inches	Merchantable length (feet)							Diameter inside bark top log, inches	Height of stump, feet	Basis, number of trees
	70	80	90	100	110	120	130			
	Volume, based on the Spaulding Rule (bd. ft.)									
20	300	380	465	550	---------	---------	---------	6.6	1.2	11
21	325	405	495	580	---------	---------	---------	6.7	1.2	
22	350	435	530	630	730	---------	---------	6.7	1.2	39
23	380	475	570	680	780	---------	---------	6.8	1.2	
24	415	510	620	730	840	---------	---------	6.9	1.3	67
25	450	560	670	785	905	---------	---------	7.0	1.3	
26	490	605	725	845	975	1100	---------	7.1	1.3	92
27	---------	655	780	915	1050	1180	---------	7.1	1.3	
28	---------	710	845	980	1130	1270	1415	7.2	1.3	100
29	---------	---------	910	1060	1210	1365	1520	7.3	1.3	
30	---------	---------	980	1140	1300	1460	1630	7.4	1.3	65
31	---------	---------	---------	1225	1395	1565	1750	7.5	1.3	
32	---------	---------	---------	1310	1490	1675	1870	7.6	1.4	57
33	---------	---------	---------	1400	1585	1780	1990	7.7	1.4	
34	---------	---------	---------	1495	1695	1900	2125	7.8	1.3	29
35	---------	---------	---------	---------	1800	2020	2255	7.9	1.3	
36	---------	---------	---------	---------	1910	2140	2400	8.0	1.4	27
37	---------	---------	---------	---------	---------	2265	2550	8.2	1.4	
38	---------	---------	---------	---------	---------	2395	2700	8.5	1.5	7
39	---------	---------	---------	---------	---------	2525	2850	9.0	1.5	
40	---------	---------	---------	---------	---------	2660	3005	9.6	1.5	8
Total number of trees										502

This table is based upon the original measurements of 502 trees.

TABLE 3. (A transformation of Table 2.) Average volume in board feet, as shown by the Ropp Log Rule, contained in merchantable portion of immature western yellow pine trees of different merchantable lengths and diameters breasthigh.

TABLE 3.

Diameter breasthigh in inches	Merchantable length (feet)							Diameter inside bark top log, inches	Height of stump, feet	Basis, number of trees
	70	80	90	100	110	120	130			
	Volume, based on the Ropp Log Rule (bd. ft.)									
20	248	322	402	481	---------	---------	---------	6.6	1.2	11
21	274	348	433	512	---------	---------	---------	6.7	1.2	
22	300	380	469	564	659	---------	---------	6.7	1.2	39
23	331	421	511	616	710	---------	---------	6.8	1.2	
24	368	458	563	668	772	---------	---------	6.9	1.3	67
25	404	509	615	725	841	---------	---------	7.0	1.3	
26	446	556	672	787	913	1036	---------	7.1	1.3	92
27	---------	608	730	861	992	1118	---------	7.1	1.3	
28	---------	666	796	929	1076	1211	1353	7.2	1.3	100
29	---------	---------	874	1011	1159	1310	1463	7.3	1.3	
30	---------	---------	938	1045	1252	1410	1578	7.4	1.3	65
31	---------	---------	---------	1182	1350	1520	1702	7.5	1.3	
32	---------	---------	---------	1271	1450	1632	1829	7.6	1.4	57
33	---------	---------	---------	1365	1550	1745	1952	7.7	1.4	
34	---------	---------	---------	1464	1663	1868	2094	7.8	1.3	29
35	---------	---------	---------	---------	1771	1905	2230	7.9	1.3	
36	---------	---------	---------	---------	1890	2120	2378	8.0	1.4	27
37	---------	---------	---------	---------	---------	2248	2535	8.2	1.4	
38	---------	---------	---------	---------	---------	2380	2690	8.5	1.5	7
39	---------	---------	---------	---------	---------	2520	2850	9.0	1.5	
40	---------	---------	---------	---------	---------	2630	3010	9.6	1.5	8
Total number of trees										502

This table was obtained by transforming the values in Table 2, based on the Spaulding Log Rule, to values shown here based upon the Ropp rule. The transformation was made in accordance with the underlying principles of both rules, and was accomplished as follows: To each value shown in Table 2 twice the merchantable length indicated at top of table was added. The new values thus obtained were divided by (1 — .266) and multiplied by (1 — .236), and three times the merchantable length subtracted. The resulting table is based upon the Ropp rule, and does not include any logs under 10″ in diameter, since logs below this size have been automatically discarded by the Ropp rule formula, which gives small negative results for logs under 8″ and small positive results for logs between 8″ and 10″. The negatives below 8″ and the positives between an 8″ and 10″ will about neutralize, thus giving a table which does not include logs below 10″ in diameter.

TABLE 4. (A transformation of Table 2.) Average values in board feet, as shown by the Vermont Log Rule, contained in merchantable portion of immature western yellow pine trees of different merchantable lengths and diameters breasthigh.

TABLE 4.

Diameter breasthigh in inches	Merchantable length (feet)							Diameter inside bark top log, inches	Height of stump, feet	Basis, number of trees
	70	80	90	100	110	120	130			
	Volume, based on the Vermont Rule (bd. ft.)									
20	382	469	560	651	---------	---------	---------	6.6	1.2	11
21	404	491	587	677	---------	---------	---------	6.7	1.2	
22	426	517	617	721	825	---------	---------	6.7	1.2	39
23	452	552	652	764	868	---------	---------	6.8	1.2	
24	482	582	695	807	922	---------	---------	6.9	1.3	67
25	512	625	738	855	977	---------	---------	7.0	1.3	
26	547	665	786	908	1039	1164	---------	7.1	1.3	92
27	---------	708	834	969	1103	1232	---------	7.1	1.3	
28	---------	755	890	1025	1172	1311	1454	7.2	1.3	100
29	---------	---------	954	1094	1242	1395	1546	7.3	1.3	
30	---------	---------	1008	1163	1320	1478	1641	7.4	1.3	65
31	---------	---------	---------	1238	1403	1568	1746	7.5	1.3	
32	---------	---------	---------	1312	1486	1663	1850	7.6	1.4	57
33	---------	---------	---------	1390	1568	1754	1954	7.7	1.4	
34	---------	---------	---------	1471	1663	1860	2072	7.8	1.3	29
35	---------	---------	---------	---------	1754	1962	2182	7.9	1.3	
36	---------	---------	---------	---------	1850	2068	2310	8.0	1.4	27
37	---------	---------	---------	---------	---------	2175	2440	8.2	1.4	
38	---------	---------	---------	---------	---------	2287	2572	8.5	1.5	7
39	---------	---------	---------	---------	---------	2400	2705	9.0	1.5	
40	---------	---------	---------	---------	---------	2520	2835	9.6	1.5	8
Total number of trees										502

This table was obtained by transforming the values in Table 2, based upon the Spaulding Log Rule, to values shown here based upon the Vermont Rule. The transformation was made in the following manner: To each value shown in Table 2, twice the merchantable length indicated at top of table was added to each of the values. Each of the new values thus obtained was divided by (1 — .266) and multiplied by (1 — .363). The resulting values form the above table, and include all logs contained in the merchantable lengths. This table is the same as would have been obtained had the results been based directly upon the woods measurements.

TABLE 5. (A transformation of Table 2.) Average values in cubic feet as shown by the Inscribed Square Log Rule contained in the largest square timbers that can be sawed from the merchantable portion of immature western yellow pine trees of different merchantable lengths and diameters breasthigh.

TABLE 5.

Diameter breast-high in inches	Merchantable length (feet)							Diameter inside bark top log, inches	Height of stump, feet	Basis, number of trees
	70	80	90	100	110	120	130			
	Volume, based on the Inscribed Square Rule (cu. ft.)									
20	31.8	39.1	46.7	54.3	---------	---------	---------	6.6	1.2	11
21	33.7	40.9	48.8	56.4	---------	---------	---------	6.7	1.2	
22	35.5	43.1	51.4	60.0	68.7	---------	---------	6.7	1.2	39
23	37.6	46.0	54.3	63.6	72.3	---------	---------	6.8	1.2	
24	40.2	48.5	57.9	67.4	76.8	---------	---------	6.9	1.3	67
25	42.7	52.1	61.5	71.3	81.4	---------	---------	7.0	1.3	
26	45.6	55.4	65.5	75.7	86.5	97.0	---------	7.1	1.3	92
27	---------	59.0	69.5	80.7	92.0	102.7	---------	7.1	1.3	
28	---------	62.9	74.2	85.5	97.7	109.3	121.1	7.2	1.3	100
29	---------	---------	79.4	91.2	103.6	116.2	128.8	7.3	1.3	
30	---------	---------	84.0	97.0	110.0	123.0	136.8	7.4	1.3	65
31	---------	---------	---------	103.2	117.0	130.7	145.4	7.5	1.3	
32	---------	---------	---------	109.3	123.8	138.7	154.0	7.6	1.4	57
33	---------	---------	---------	115.8	130.7	146.1	162.8	7.7	1.4	
34	---------	---------	---------	122.6	138.7	155.0	172.5	7.8	1.3	29
35	---------	---------	---------	---------	146.2	163.5	182.0	7.9	1.3	
36	---------	---------	---------	---------	154.2	172.3	192.5	8.0	1.4	27
37	---------	---------	---------	---------	---------	181.2	203.2	8.2	1.4	
38	---------	---------	---------	---------	---------	190.8	214.0	8.5	1.5	7
39	---------	---------	---------	---------	---------	200.0	225.3	9.0	1.5	
40	---------	---------	---------	---------	---------	210.0	236.0	9.6	1.5	8
Total number of trees										502

Values in this table are indirectly based upon the measurements necessary for a compilation of Table 2. They were obtained by dividing values shown in Table 4 by the constant 12.

THE TRANSFORMATION OF THE SCALE OF A NUMBER OF LOGS IN THE AGGREGATE, BASED UPON A GIVEN LOG RULE, TO THE SCALE OF THE SAME LOGS IN THE AGGREGATE, BASED UPON ANOTHER LOG RULE.

The total volume of a number of logs of various sizes as shown by a log rule of the form $(1-c)\frac{\pi(D-a)^2}{4\times 12}L=\text{B.M.}$ can be transformed to the volume as would be shown by another log rule of that form where the constant a is the same. For example: Should it be required to know the total volume in board feet of a trainload of logs of various sizes as would be shown by the Boughman Band Saw Rule when the aggregate scale based upon the Baxter Rule is known to be 320,000 board feet, the following steps are necessary: Divide 320,000 by $(1-c)$ of the Baxter rule, which is $(1-.338)$, and multiply by $(1-c)$ of the Boughman Band Saw Rule, which is $(1-.10)$. The result thus obtained which will be 435,000 is the same as would have been obtained had the Bowman rule been used for the original scale. Such transformations can not be made where the constant a in the two rules in question are not the same. Had the trainload of logs been scaled by a rule of the form $(1-c)\frac{\pi D^2}{4\times 12}L=\text{B.M.}$ it would not be possible to make such a transformation, but it would be possible to transform the total scale to a new total based upon another rule of the same form. For example: If a trainload of logs should scale 300,000 board feet by the Square of Three-quarters rule, and it should be required to find the aggregate scale according to the Inscribed Square rule, the following procedure is all that is necessary: Divide 300,000 by $(1-.283)$ and multiply by $(1-.363)$ and then divide by 12. The final result, 32,000 cubic feet, is exactly the same as would have been obtained had the Inscribed Square rule been used for the original scale. In like manner, a transformation could have been made to a number of other rules of similar form.

Had the trainload of logs been originally scaled by a log rule of the form $\left[(1-c)\frac{D^2}{4\times 12}-b\right]L=\text{B.M.}$, such as the Spaulding rule, a transformation to another rule of that form where b is the same could be accomplished by dividing by $(1-c)$ of the formula used and multiplying by $(1-c)$ of the formula to which the transformation is to be made. But, in cases where the value of the constant b is different in the log rules in question, no reduction can be made, unless the sum of the length of all the logs in the trainload be known. If the sum of all log lengths is known, it would then be possible to transform the total scale to other total scales based upon $\left[(1-c)\frac{\pi D^2}{4\times 12}-b\right]L=\text{B.M.}$ or $(1-c)\frac{\pi D^2}{4\times 12}L=\text{B.M.}$ whether the constant b is the same or different in the rules in question. Had the trainload of logs been originally scaled by the Spaulding Log Rule, or any other rule of similar form, where b has a value greater than 0, the transformation of the total scale to a total based on a log rule of the form $(1-c)\frac{\pi D^2}{4 \times 12}L = \text{B.M.}$ would be impossible unless the sum of the lengths of all logs in the trainload be known. Suppose, for example, the aggregate scale of a trainload of logs was 250,000 board feet by the Spaulding Log Rule, and the sum of all log lengths in the load was 12,000 linear feet, and it was required to know the total scale when based upon the Square of Two-thirds rule, the following operations are all that would be necessary: Add to 250,000 twice the sum of all log lengths, which would be 24,000, divide by $(1 - .266)$ and multiply by $(1 - .435)$. The resulting aggregate scale of the trainload of logs based on the Square of Two-thirds rule would then be 211,000 board feet, which is the same as would have been obtained had the Square of Two-thirds rule been originally applied.

SUMMARY.

No log rule will give an accurate measure of the lumber content of logs of various sizes that fails to properly combine all the factors encountered in converting logs into lumber. These factors are the same for all species under all milling conditions. The value of the factors alone increases or decreases according to the species and method of sawing, but the number of factors remain constant. As a result of failing to recognize the factors that must be combined in devising a properly constructed log rule, by failing to employ all of them, or by combining them improperly, there is no accurate log rule in use applicable to variable milling conditions. Any log rule capable of becoming a standard measure and susceptible of correction for certain variable factors must recognize a slab allowance proportional to the barked area of the log, and a sawdust allowance expressed as a definite per cent of the total volume of all logs, not including slabs. The per cent for sawdust is dependent upon the width of the saw-kerf and average dimensions of lumber to be sawed. Other factors to be taken into account are taper, shrinkage, normal crook and excessive taper in small logs, but these are of less importance than the two cited above.

The following log rules are constructed with a total wastage allowance proportional to the total volume of the log, regardless of size—taper not considered:

Constantine, Saco River, Derby, Square of Three-quarters, Partridge, Vermont, Stillwell, Ake, Square of Two-thirds, Orange River, Cumberland River. These rules are incorrect in principle, therefore no correction is possible.

Another group of rules is derived by substituting a waste allowance proportional to total volume, plus a constant for logs of different sizes—taper not considered. It would seem as though some effort had been made to correct the inaccuracy of the preceding group by adding a constant to compensate for waste occasioned by sawing logs of different sizes. The underlying principles of these rules are incorrect, however, and consequently their values cannot be properly adjusted. Such rules are the following:

Bangor, Boynton, Parsons, Warner, Spaulding, Hannah, Wilcox, Finch and Apgar, Ropp, Scribner, Favorite, Maine, Herring, Dusenbury.

Log rules with slab allowance varying directly as the barked area of logs of different sizes and with sawdust allowance directly as the volume after the slab allowance has been made are correct in principle, but are not necessarily correct measures. Rules of this type are as follows:

Champlain, Boughman's Rotary Saw, Boughman's Band Saw, Wilson, Carey, Baxter, Click, British Columbia, Universal, International, Preston, Doyle, McKenzie.

Of the preceding rules the Champlain, Universal, International and McKenzie are the only ones that are at all flexible to milling conditions and character of timber to be sawed. The Champlain and the Universal are the same, with the exception of the slab allowance, which in the case of the Universal is twice as great as for the Champlain. The sawdust allowance for both rules is made by allowing $\left(100 - \frac{100}{1+k}\right)$ per cent of the volume of the log (taper not included) for sawdust. This factor is correct for a gang saw with saws k'' thick and $1''$ apart, but does not apply to any other milling conditions. Taper is not taken into consideration by either of these rules. Both rules have a fixed slab allowance, and the sawdust factor is affected by saw-kerf alone.

The International Log Rule also has a fixed slab allowance, and the sawdust allowance is unaffected by the dimensions of the lumber to be sawed. The value of this factor has been worked out for different gauge saws, and is the same regardless of dimensions of the manufactured product. The rule has a fixed taper allowance of $\frac{1}{2}''$ in $4'$, and tables compiled in accordance with the rule are based upon $4'$ sections.

Since the analysis proved that no log rule now in use is universally applicable, a rule has been prepared and designated the McKenzie rule, which may be made to apply accurately to any set of conditions and at all times be susceptible to proper corrections made necessary by modifications of local methods employed.

This rule, with no allowance made for shrinkage and surfacing, is shown on page 19, and for convenience may be written:

$$\left[1-\frac{(w+k)\ (t+k)\ -wt}{(w+k)\ (t+k)}\right]\frac{\pi\,(D-a)^2}{4\times 12}L+C=\text{B.M.}$$

With an allowance for shrinkage and surfacing included, the rule complete becomes:

$$\left[1-\frac{(w+c+k)\ \ (t+b+k)-wt}{(w+c+k)\ \ (t+b+k)}\right]\frac{\pi\,(D-a)^2}{4\times 12}L+C=\text{B.M.}$$

Where b and c in inches, represent these allowances in thickness and width, respectively.

APPENDIX.

How to Adjust the McKenzie Log Rule to Conditions Existing at Any Mill.

This can best be shown by assuming a set of conditions and then reducing the rule from its general form to a special form in accordance with whatever the limitations imposed may be. For example, assume the following:

Mill output for period of three months:

150,000	bd. ft. of	1″ × 3″	cut	1 1/16″ × 3 1/8″
120,000	bd. ft. of	1″ × 4″	cut	1 1/16″ × 4 1/8″
180,000	bd. ft. of	1″ × 6″	cut	1 1/16″ × 6 1/8″
225,000	bd. ft. of	1″ × 8″	cut	1 1/16″ × 8 1/8″
700,000	bd. ft. of	1″ × 12″	cut	1 1/16″ × 12 1/4″
550,000	bd. ft. of	1″ × 14″	cut	1 1/16″ × 14 1/4″
300,000	bd. ft. of	1″ × 16″	cut	1 1/16″ × 16 1/4″
270,000	bd. ft. of	1″ × 18″	cut	1 1/16″ × 18 1/4″
180,000	bd. ft. of	6/4″ × 8″	cut	1 9/16″ × 8 1/8″
275,000	bd. ft. of	6/4″ × 10″	cut	1 9/16″ × 10 1/8″
500,000	bd. ft. of	6/4″ × 12″	cut	1 9/16″ × 12 1/4″
300,000	bd. ft. of	6/4″ × 14″	cut	1 9/16″ × 14 1/4″
275,000	bd. ft. of	6/4″ × 16″	cut	1 9/16″ × 16 1/4″
240,000	bd. ft. of	6/4″ × 18″	cut	1 9/16″ × 18 1/4″
600,000	bd. ft. of	2″ × 4″	cut	2 1/8″ × 4 1/8″
450,000	bd. ft. of	2″ × 6″	cut	2 1/8″ × 6 1/8″
225,000	bd. ft. of	2″ × 8″	cut	2 1/8″ × 8 1/8″
175,000	bd. ft. of	2″ × 10″	cut	2 1/8″ × 10 1/8″
200,000	bd. ft. of	2″ × 12″	cut	2 1/8″ × 12 1/4″
210,000	bd. ft. of	3″ × 3″	cut	3 1/8″ × 3 1/8″
270,000	bd. ft. of	3″ × 6″	cut	3 1/8″ × 6 1/8″
250,000	bd. ft. of	3″ × 12″	cut	3 1/8″ × 12 1/4″
300,000	bd. ft. of	4″ × 4″	cut	4 1/8″ × 4 1/8″
150,000	bd. ft. of	4″ × 6″	cut	4 1/8″ × 6 1/8″
375,000	bd. ft. of	5″ × 8″	cut	5 1/8″ × 8 1/8″
180,000	bd. ft. of	6″ × 6″	cut	6 3/16″ × 6 3/16″
120,000	bd. ft. of	6″ × 8″	cut	6 3/16″ × 8 3/16″
275,000	bd. ft. of	7″ × 9″	cut	7 3/16″ × 9 3/16″
250,000	bd. ft. of	8″ × 8″	cut	8 1/4″ × 8 1/4″
200,000	bd. ft. of	8″ × 12″	cut	8 1/4″ × 12 1/4″
375,000	bd. ft. of	8″ × 16″	cut	8 1/4″ × 16 1/4″
190,000	bd. ft. of	12″ × 12″	cut	12 1/4″ × 12 1/4″

Width of saw kerf = 1/8″
Average taper (not including butt logs or top logs)
= approx. 1/2″ in 8′
Average thickness of slabs and edgings at small end of logs = 5/8″
To determine a special form of

$$\left[1 - \frac{(w+c+k)\ (t+b+k) - wt}{(w+c+k)\ (t+b+k)}\right] \frac{\pi\,(D-a)^2}{4 \times 12} L + C = \text{B.M.}$$

which will conform to the above milling conditions and character of timber.

(*a*) The determination of the average value of

$$\left[1-\frac{(w+c+k)\ \ (t+b+k)-wt}{(w+c+k)\ \ (t+b+k)}\right]\ (A)$$

For 1″ × 3″ lumber cut 1 1/16″ × 3 1/8″

$w=3,\quad c=1/8=.125,\quad k=1/8=.125$

$t=1,\quad b=1/16=.0625$

$(w+c+k)=3.+.125+.125=3.25$

$(t+b+k)=1+.062+.125=1.187$

$(w+c+k)\ (t+b+k)=3.25\times 1.187=3.86$

$wt=1\times 3=3$

$$\text{Then }(A)=1-\frac{3.86-3}{3.86}=1-.223=.777$$

Therefore 150,000 bd. ft. represents 77.7% of the original material, or 22.3% has been forfeited to sawdust, shrinkage and surfacing in manufacturing 1″ × 3″ lumber, cut 1 1/16″ × 3 1/8″ when saw kerf = 1/8″

$$\frac{150{,}000}{.777}=193{,}000=\text{the volume in bd. ft. of material actually used}$$

in producing 150,000 bd. ft. of 1″ × 3″ lumber (not including slabs and edgings).

With simliar determinations made for all other dimensions of lumber cut, we have:

150,000 bd. ft. of 1″ × 3″ cut 1 1/16″ × 3 1/8″ requiring 193,000 bd. ft. of solid material.
120,000 bd. ft. of 1″ × 4″ cut 1 1/16″ × 4 1/8″ requiring 151,000 bd. ft. of solid material.
180,000 bd. ft. of 1″ × 6″ cut 1 1/16″ × 6 1/8″ requiring 222,000 bd. ft. of solid material.
225,000 bd. ft. of 1″ × 8″ cut 1 1/16″ × 8 1/8″ requiring 276,000 bd. ft. of solid material.
700,000 bd. ft. of 1″ × 12″ cut 1 1/16″ × 12 1/4″ requiring 857,000 bd. ft. of solid material.
550,000 bd. ft. of 1″ × 14″ cut 1 1/16″ × 14 1/4″ requiring 672,000 bd. ft. of solid material.
300,000 bd. ft. of 1″ × 16″ cut 1 1/16″ × 16 1/4″ requiring 364,000 bd. ft. of solid material.
270,000 bd. ft. of 1″ × 18″ cut 1 1/16″ × 18 1/4″ requiring 327,000 bd. ft. of solid material.
180,000 bd. ft. of 6/4″ × 8″ cut 1 9/16″ × 8 1/8″ requiring 209,000 bd. ft. of solid material.
275,000 bd. ft. of 6/4″ × 10″ cut 1 9/16″ × 10 1/8″ requiring 317,000 bd. ft. of solid material.
500,000 bd. ft. of 6/4″ × 12″ cut 1 9/16″ × 12 1/4″ requiring 579,000 bd. ft. of solid material.
300,000 bd. ft. of 6/4″ × 14″ cut 1 9/16″ × 14 1/4″ requiring 346,000 bd. ft. of solid material.
275,000 bd. ft. of 6/4″ × 16″ cut 1 9/16″ × 16 1/4″ requiring 316,000 bd. ft. of solid material.
240,000 bd. ft. of 6/4″ × 18″ cut 1 9/16″ × 18 1/4″ requiring 275,000 bd. ft. of solid material.
600,000 bd. ft. of 2″ × 4″ cut 2 1/8″ × 4 1/8″ requiring 718,000 bd. ft. of solid material.
450,000 bd. ft. of 2″ × 6″ cut 2 1/8″ × 6 1/8″ requiring 529,000 bd. ft. of solid material.
225,000 bd. ft. of 2″ × 8″ cut 2 1/8″ × 8 1/8″ requiring 261,000 bd. ft. of solid material.
175,000 bd. ft. of 2″ × 10″ cut 2 1/8″ × 10 1/8″ requiring 202,000 bd. ft. of solid material.
200,000 bd. ft. of 2″ × 12″ cut 2 1/8″ × 12 1/4″ requiring 232,000 bd. ft. of solid material.
210,000 bd. ft. of 3″ × 3″ cut 3 1/8″ × 3 1/8″ requiring 246,000 bd. ft. of solid material.
270,000 bd. ft. of 3″ × 6″ cut 3 1/8″ × 6 1/8″ requiring 304,000 bd. ft. of solid material.
250,000 bd. ft. of 3″ × 12″ cut 3 1/8″ × 12 1/4″ requiring 279,000 bd. ft. of solid material.
300,000 bd. ft. of 4″ × 4″ cut 4 1/8″ × 4 1/8″ requiring 340,000 bd. ft. of solid material.
150,000 bd. ft. of 4″ × 6″ cut 4 1/8″ × 6 1/8″ requiring 166,000 bd. ft. of solid material.
375,000 bd. ft. of 5″ × 8″ cut 5 1/8″ × 8 1/8″ requiring 405,000 bd. ft. of solid material.
180,000 bd. ft. of 6″ × 6″ cut 6 3/16″ × 6 3/16″ requiring 199,000 bd. ft. of solid material.
120,000 bd. ft. of 6″ × 8″ cut 6 3/16″ × 8 3/16″ requiring 131,000 bd. ft. of solid material.
275,000 bd. ft. of 7″ × 9″ cut 7 3/16″ × 9 3/16″ requiring 297,000 bd. ft. of solid material.
250,000 bd. ft. of 8″ × 8″ cut 8 1/4″ × 8 1/4″ requiring 277,000 bd. ft. of solid material.
200,000 bd. ft. of 8″ × 12″ cut 8 1/4″ × 12 1/4″ requiring 216,000 bd. ft. of solid material.
375,000 bd. ft. of 8″ × 16″ cut 8 1/4″ × 16 1/4″ requiring 402,000 bd. ft. of solid material.
190,000 bd. ft. of 12″ × 12″ cut 12 1/4″ × 12 1/4″ requiring 202,000 bd. ft. of solid material.

9,060,000 bd. ft. is manufactured from________________________10,510,000 bd. ft. of solid material,
not including the wastage necessary for slabs and edgings.

10,510,000 — 9,060,000 = 1,450,000 bd. ft. required for sawdust, shrinkage and surfacing.

$\frac{1,450,000}{10,510,000} = .138$ = fractional part of the logs, after slab allowance has been made, which becomes waste.

(1 — .138) = fractional part becoming lumber.

Therefore the average value of (A) becomes (1 — .138) for the above milling conditions.

(*b*) The determination of slab allowance or surface wastage:

This allowance is provided for in the formula by the constant "a", which represents twice the average thickness of the slabs and edgings coming from the small end of logs, regardless of their length. The value of "a" can be closely estimated at any mill by watching the logs being sawed into lumber. If the character of the timber being sawed is such that a waste allowance, additional to that made for slabs and edgings is necessary, to correct for losses due to crook, such an allowance should be made by increasing the value of the factor "a" to a sufficient amount to offset losses caused by such defects.

For the milling conditions under consideration here, the value of "a" is assumed to be 5/8″ × 2, or 1.25. Substituting this value and the average value of (A), already determined, in the general formula, we have the following special form:

$$(1 - .223)\,\frac{\pi\,(D - 1.25)^2}{4 \times 12}\,L + C = \text{B.M.}$$

for logs L feet long with no allowance made for taper.

For 8′ sections this form becomes:

$$(1 - .223)\,\frac{\pi\,(D - 1.25)^2}{6} + C$$

or

$$.407\ (D - 1.25)^2 + C = \text{B.M.}$$

The constant *C* is included in the formula to counteract excessive taper in small logs, and its value should never be over 10 board feet. It can be definitely determined for a certain class of timber, by first ascertaining the mill overrun for small logs when $C = o$, and then making the value of *C* great enough to correct for the overrun. Large logs will be affected a negligible amount by the addition of this small quantity.

With $C = 3$ board feet, we have for the final reduction of the general rule:

$$.407\ (D - 1.25)^2 + 3 = \text{B.M.}$$

to be applied to 8′ sections with a taper of 1/2″ in each 8′.

A volume table based on the above rule with a taper allowance of 1/2″ in 8′ should be compiled as follows:

Length in feet	DIAMETER IN INCHES									
	6	7	8	9	10	11	12	13	14	15
	BOARD FEET									
8	12	16	22	28	34	42	50	59	69	80
9	14	18	25							
10	16	21	28							
11	17	23	31							
12	19	26	34							
13	21	28	38							
14	22	30	41							
15	24	33	44							
16	26	35	47	59	72	98	104	123	144	
17	28	38	50							
18	30	41	54							
19	32	43	57							
20	34	46	61							
21	36	49	64							
22	38	51	68							
23	40	54	71							
24	42	57	75	93	114	148	163	192	224	

Values for 8′ sections of different diameters are first determined directly from the formula. Then 16′ logs are considered as being made up of two 8′ sections, the one being one-half inch in diameter greater than the other; 24′ logs as three 8′ sections, one of them being the measured diameter at small end of log, another one, one-half inch greater than this, and the third, one inch greater. Thus, 26 board feet, which is the volume given in the above table for a log 16′ long and 6″ in diameter, was obtained by adding 12 board feet, which is the volume given for an 8′ section of same diameter, and 14 board feet obtained by averaging twelve and sixteen. (The average of 12 and 16 board feet gives volume for 8′ section, six and one-half inches in diameter.) The volume of the 24′ log of six inches in diameter shown in the table was obtained by adding 26 and 16. Twenty-six board feet being the volume of the first two 8′ sections contained in the log and sixteen board feet being the volume of the third or largest section. Other values may be obtained in a similar manner.

If the taper allowance were 1″ in 8′ instead of 1/2″ in 8′, a 16′ log 6″ in diameter at the small end would scale the same as two 8′ sections; the one 6″ in diameter and the other 7″. A 24′ log 20″ in diameter would, in like manner, scale the same as three 8′ sections; the first 20″, the second 21″ and the third 22″ in diameter. If this log were 22′ long instead of 24′ the scale would then be equal to that of the first two sections plus three-quarters of the third. By similar computations, all values composing a complete volume table for logs of different diameters and lengths can be compiled.

Log rules determined as explained in this Appendix apply to average conditions existing at the mills where they are made and are average rules which do not measure the fluctuations encountered in individual logs.

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A Mill Scale Study
of
Western Yellow Pine

By HERMAN E. McKENZIE

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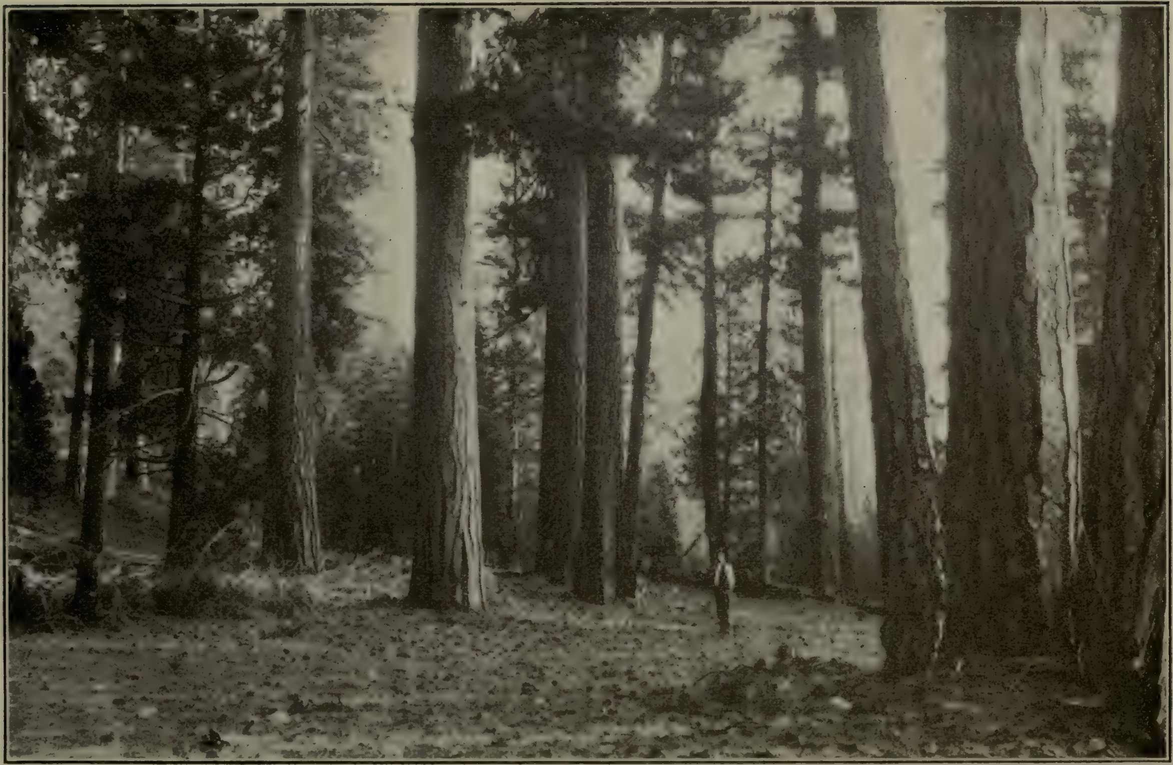


PLATE I. A Typical Stand of Immature and Mature Western Yellow Pine.

INTRODUCTION.

THE solutions of many of the numerous problems encountered in the economic management of merchantable forests depend upon the present and probable future market conditions; the present and probable future cost of logging, milling and transportation; and upon a definite knowledge of the quality and quantity of lumber contained in trees of various sizes, along with the yearly increase in quality and quantity due to growth.

The question often arises: Is it more profitable to leave certain trees standing than to cut them down and invest the profits obtained thereby, or is it more profitable to allow them to grow and accumulate interest in the form of wood added each year, along with a possible increase in value due to change in market conditions, or perhaps to future betterment of transportation facilities? Such questions can not intelligently be dealt with unless at least the quality and quantity of trees of different sizes, as well as yearly increase in both quality and quantity of lumber contained in them, be quite definitely known. It is the object of this study to make such determinations for western yellow pine that can be used in the solution of the above and similar problems; also, that can be used in connection with more accurate valuation surveys than have been made in the past, and which will help lumbermen and timber owners in general to more economically formulate their policies of handling merchantable yellow pine forests.

The study is based upon nine hundred and nineteen trees, ranging from twenty to forty-four inches in diameter breasthigh, five hundred and seven of which were classified, according to outward appearances, as bull pine, and four hundred and twelve as typical yellow pine. A complete analysis of quality and quantity of lumber produced from these trees, also from the butt logs, the best part, and the top logs, the poorest part of the trees, has been made and the results arranged on opposite pages throughout this bulletin, so that a comparison of the two forms may be had. The values shown in the tables in Part III were read from the curves shown in Part II, which were in turn plotted directly from averages obtained from the original data. References are made with each table, such that it is possible to trace any value there recorded back to its original derivation.

Each feature has been presented in detail and will be of direct value to lumbermen operating in pine forests under similar conditions. Yellow pine stands constitute the predominating forest type in California and, consequently, this type affords a characteristic set of conditions under which to initiate such a piece of work. Prepared thus in detail, it offers to lumbermen in other types of forest a valuable outline for the accomplishment of similar investigations, since most of the determinations herein are unaffected by varying conditions, such as market fluctuations and transportation facilities, and since all the principles can be made to apply to money values which are modified from year to year.

PART I—FIELD WORK.

THE STAND.

At an elevation of 5,400 feet and growing in soil rich in moisture and of volcanic origin, the forest in which this mill scale study was conducted consisted of a stand in which western yellow pine (*Pinus ponderosa*) predominated in association with a conspicuous growth of white fir (*Abies concolor*) and an occasional Douglas fir (*Pseudotsuga taxifolia*). The forest, located in the southern part of Lassen County, California, is being exploited by the Red River Lumber Company. The local topography is characteristically level with conspicuous rock outcroppings so frequently encountered in sections of the yellow pine and sugar pine regions of California. The uneven-aged stand cruises approximately 25,000 board feet to the acre, and is characterized by the presence of two distinct forms of yellow pine: namely, ''yellow pine,'' averaging in height about 130 feet, and ''bull pine'' or ''blackjack,'' having an average height of approximately 120 feet. Although locally known by these names, the two forms have been studied separately and are referred to respectively as ''mature yellow pine'' and ''immature yellow pine,'' since it is believed that the variance is due solely to a difference in age of trees of the same diameters.

The rainfall is abundant but not heavy, and several small streams drain the area and flow throughout the year. The region is one of an open forest, free from abundant low growing species, and is further characterized by numerous small mountain meadows, open glades in which grass constitutes the main vegetation; these meadows vary in size, but seldom exceed twenty acres in extent except for the very large meadows, which are frequently several miles across.

The stand consists of trees of good quality, free from defects except for the general fire-scarred butts which give evidence of past fires. These scars are healed over and do not materially affect the quality of the stand. The average age of the two forms of yellow pine are respectively 350 and 250 years. The average diameter of the mature yellow pine is about thirty-six inches and for the immature yellow pine about twenty-eight inches.

THE MILL.

The mill operated by the Red River Lumber Company on its holdings at Westwood, Lassen County, during the summer of 1913, was of modern band-saw type, electrically equipped with separate motor drives for each piece of machinery. Its capacity was 50,000 board feet for an eleven-hour shift. The saw used was 16 gauge and 12 swedge—one-tenth inch thick with cutting edge one-eighth inch wide. The log carriage was ''shotgun'' type limited to logs of not less than eight feet and not more than twenty-four feet in length. The diameter of the largest log that could be sawed was forty-six inches at the large end.

These features of the mill influenced to a marked degree the final results of the study, and are the only ones pertaining to the mill proper deemed of importance in connection with this work.

PARTY AND EQUIPMENT.

The party organization and necessary equipment of the men is shown as follows:

In the woods	Two falling crews	One member of party with each crew, and equipped as follows: 50-inch tree calipers; 100-foot steel tape; blue lumber crayon; sharp knife and pad of blank forms the same as shown in Plate II.
	Two bunching teams	Two members of party with each bunching team, and equipped as follows: 36-inch measuring stick divided into inches and tenths of inches; 50-foot steel tape; one-foot steel stem analysis scale divided into inches and tenths on the one edge, and into inches and twentieths on the other; blue lumber crayon, and two pads of blank forms as shown in Plates II and III, one for recording stem analysis data, and the other for recording log measurements.
At the mill	Stationed at log deck	Company's log scaler, who recorded on separate pad the volume in board feet, as shown by the Spaulding Log Scale, of each marked log sent up the log chute to be milled.
	Stationed at edger	One member of party equipped with blue lumber crayon for marking first and last board from each marked log, and blank pad for recording timbers, if any, sawed from them.
	Stationed at grading table	One member of party equipped with pad of blank forms as shown in Plates IV to X, who recorded the volume and grade of lumber from each marked log as called off to him by the company's grader as he entered same on his tally sheet.

The mill was operated with day and night shifts, therefore two members of the party were required to do night work, thus making four men in all stationed at the mill.

METHOD OF PROCEDURE.

In the Woods.

Identification.

The men stationed with the falling crews identified all trees to be included in the study before they were felled. All trees included were western yellow pine, but of two varieties known locally as typical yellow pine and bull pine, or blackjack. The identification of each tree was exactly the same as would have been made by the lumbermen of the locality; the determining characteristics being based on general outward appearances, mostly on color, and texture of bark. Trees identified as typical yellow pine had fairly smooth bark with furrows about one-half inch deep running both horizontally and longitudinally, thus forming rather large, smooth, irregular shaped plates, which were light brown in color with a tendency toward the shade of yellow. The top part of their crowns were dome-shaped. Trees identified as bull pine, or blackjack, had rough, dark colored, cork-like bark, which was almost black in some cases. Usually small limbs, either dead or alive, were present on the lower portion of the bole, and the top part of their crowns were cone-shaped.

Tree measurements.

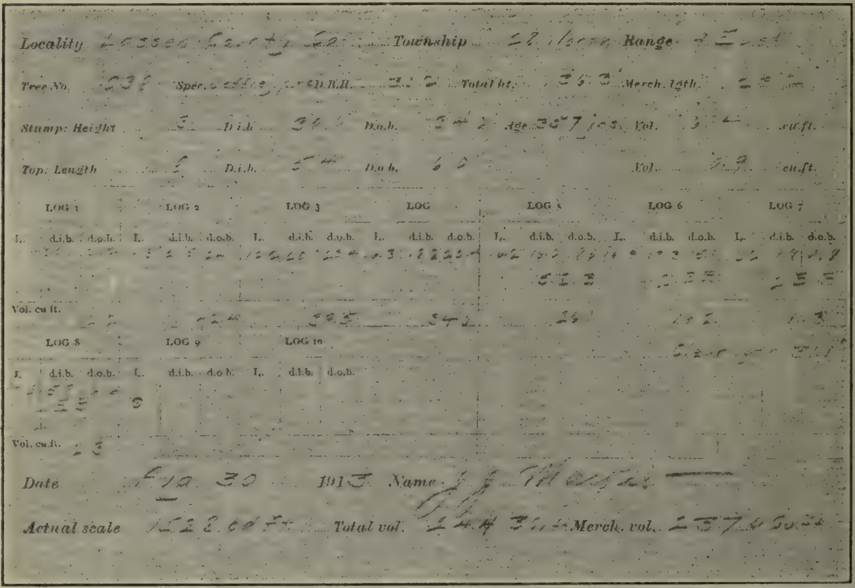
The first measurement made on each tree was diameter breasthigh in inches. This measurement, an average of the long and short diameters at right angles, was taken outside bark four and one-half feet from the ground while the trees were standing. Immediately after a tree was felled, it was given a number, which was marked plainly on the butt and also on the stump with blue lumber crayon. The clear length (the distance from the stump to the first limb or snag two inches or over in diameter), the merchantable length (the distance from the stump to where the tree was six inches in diameter outside bark), and the total height (the distance from the ground line to tip of crown) were then measured and recorded in their proper places on forms similar to the one shown in Plate II. The height of the stump was then taken, and the average radius determined.

Marking.

All trees were given a number and marked immediately after falling, and each stump was also marked with the same number as the tree. Trees identified as yellow pine were given consecutive numbers beginning with No. 1, which was the first tree identified; tree No. 2 the second identified, and so on. Trees classified as bull pine or blackjack were also given consecutive numbers, but each was preceded by a zero. Therefore, tree No. 01 indicated that the tree bearing this mark was the first measured and classified as bull pine; tree No. 02 the second, and so on. Logs cut from marked trees were given numbers which indicated the position the log held in the tree and also the number of the tree. For instance, if tree No. 425 were bucked into eight logs, beginning with the butt log, each would receive the following numbers: 4251, 4252, 4253, 4254, 4255, 4256, 4257 and 4258, the last digit of the number always indicating the position of the log in the tree. Log No. 4256 should be read the sixth log from stump of tree No. 425. The same scheme was used in numbering trees identified as bull pine. Should a log be marked 04256, the number would be translated as indicating the sixth log from the stump of tree No. 0425, which was identified as bull pine. All logs were marked plainly on both ends in blue lumber crayon with the number indicating the tree from which the log came and the position that the log occupied in the tree. Should one end of the log be broken instead of sawed, a place was smoothed off by means of a hand-axe and the number written plainly on it. In some cases logs were broken on both ends. Such logs were marked in two places, either on hewn surfaces on the broken ends or on places near each end of the log where the bark was hewn away for that purpose.

Growth measurements.

Growth measurements consisted of determination of the average radii inside the bark at the stump of all trees for each decade of their growth. The average radius inside bark of stump was ascertained by averaging the longest and shortest diameters to be found at right angles, and a



Locality .... *Township* .... *Range* ....

Tree No. .... *Spec.* .... *D.B.H.* .... *Total ht.* .... *Merch. lgth.* ....

Stump: Height .... *D.i.b.* .... *D.o.b.* .... *Age* .... *Vol.* .... *cu. ft.*

Top: Length .... *D.i.b.* .... *D.o.b.* .... *Vol.* .... *cu. ft.*

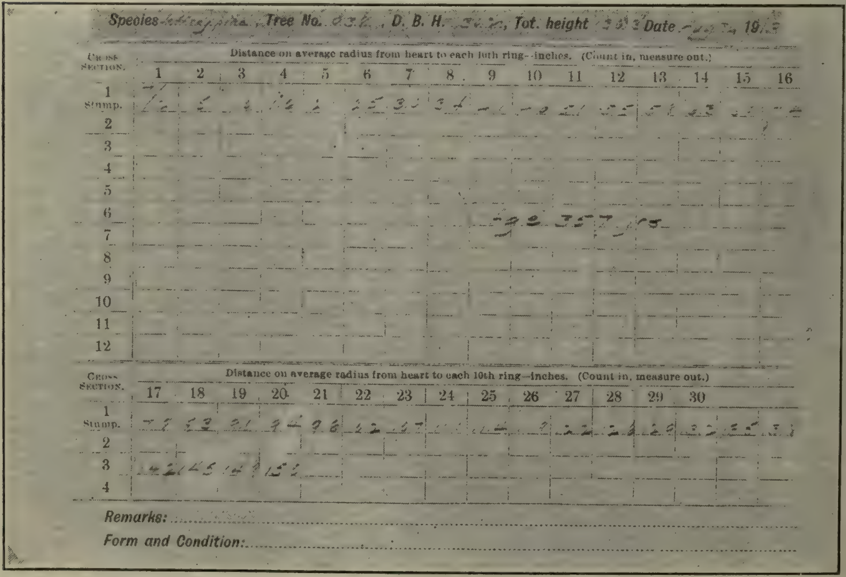
LOG 1			LOG 2			LOG 3			LOG			LOG 5			LOG 6			LOG 7		
L.	d.i.b.	d.o.b.	L.	d.i.b.	d.o.b.	L.	d.i.b.	d.o.b.	L.	d.i.b.	d.o.b.	L.	d.i.b.	d.o.b.	L.	d.i.b.	d.o.b.	L.	d.i.b.	d.o.b.
Vol. cu. ft.																				

LOG 8			LOG 9			LOG 10		
L.	d.i.b.	d.o.b.	L.	d.i.b.	d.o.b.	L.	d.i.b.	d.o.b.
Vol. cu. ft.								

Date .... 191 *Name* ....

Actual scale .... *Total vol.* .... *Merch. vol.* ....

PLATE II.—Woods Sheet for Tree No. 038.



Species .... *Tree No.* .... *D. B. H.* .... *Tot. height* .... *Date* .... *19*...

Cross Section.	Distance on average radius from heart to each 10th ring—inches. (Count in, measure out.)															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1 Stump.																
2																
3																
4																
5																
6																
7																
8																
9																
10																
11																
12																

Cross Section.	Distance on average radius from heart to each 10th ring—inches. (Count in, measure out.)													
	17	18	19	20	21	22	23	24	25	26	27	28	29	30
1 Stump.														
2														
3														
4														

Remarks: ....

Form and Condition: ....

PLATE III.—Stump Analysis Sheet for Tree No. 038.

distance from the heart of the stump to the inside of the bark was then located which was equal to the average radius determined, and a line was drawn. Annual rings were then counted along this line, starting at the bark and continuing toward the heart. A mark was placed at every tenth ring until the heart of the stump was reached. The last division near the heart usually contained less than ten rings. The age of the tree was then determined by counting the marks and multiplying by ten and adding the number of rings between the pith and the last mark. For example, if there were thirty-one marks along the average radius, and seven rings included between the pith and the last mark made, the tree's age from the time it was as high as the stump until felled would be 317 years. Radii from the pith to each mark were measured and recorded. These distances represent the radius inside bark at the stump attained by the tree at each ten year interval of growth.

Recording of data.

All data was recorded on forms prepared especially for the work. Measurements made by the men working with the falling crews were recorded on forms similar to the one shown in Plate II. Log measurements made by members of the party working with the bunching teams were also recorded on these forms, which were turned over to them each night by the men located with the falling crews. Growth measurements were recorded on separate forms as shown in Plate III. All broken sections of trees were recorded whether they were fit for milling purposes or not, and were given numbers the same as though they were logs. In some cases such sections would not measure over two feet in length and perhaps broken on both ends. They were given log numbers, however, and recorded with the following symbols added 2 E.B. and L.I.W., meaning two ends broken and left in the woods. If only one end was broken, and it happened to be the small end, the notes would read S.E.B., L.I.W., meaning that the small end was broken and the large end was sawed; also that the section was left in the woods. If the large end was broken and the small end sawed, the symbols would be L.E.B., L.I.W., meaning large end broken, small end sawed and section left in the woods. In this way all broken sections were indicated in the data and all of each tree accounted for.

Log measurements.

The lengths of all logs were measured in feet and tenths, and the average diameter inside bark, in inches and tenths. The thickness of bark was determined by averaging measurements of same taken in three or four places. The diameter outside the bark was obtained by adding twice the thickness of the bark to the inside diameter. Logs with broken ends were measured from an average of the break on one end to the average of the break on the other. The diameters of broken sections were measured in some cases with calipers, but whenever possible the measuring stick was used.

At the Mill.

Log scale.

All marked logs reaching the mill were scaled by the company's log scaler, who scaled by the Spaulding Log Rule. An allowance of one linear foot was made for each broken end of broken logs, and the number of each log was recorded along with its log scale and dimensions.

Marking.

The first and last board from each log were marked conspicuously by the member of the party stationed near the edger, and each log was recorded as it came on to the carriage. By means of this systematic marking and recording it was possible to follow closely the output of lumber from each log and, ultimately, from each tree.

Grading.

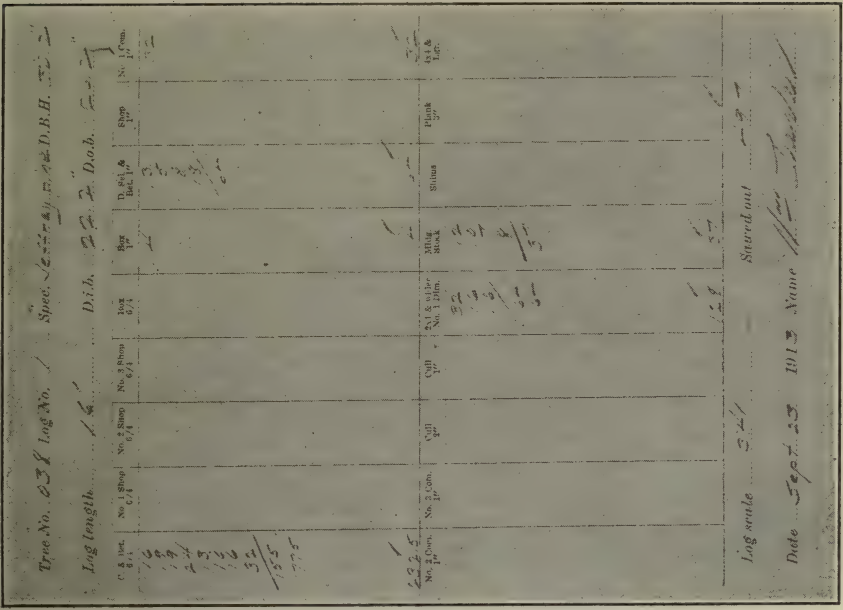
The grading was done in accordance with the rules shown on page 20 by men of long experience. The contents and grade of each board coming from marked logs were called off by the grader as he entered them on his tally sheet, thus enabling one of the party to record the same in his specially designed form book.

Recording of data.

All data pertaining to grades and volume sawed out of marked logs of various sizes, were recorded by the man stationed at the grading table on forms as shown in Plates IV to X. The log number was first entered at the top of the sheet, then the volume in board feet of each piece of lumber sawed was entered under a heading denoting the grade. The total volume in board feet of each grade was then determined by adding the figures in each column. The total sawed out, which is the total volume of all grades, was obtained by adding the totals of each separate column. This grand total was recorded in the lower right-hand corner as shown in the above mentioned plates. The volume by the Spaulding Log Rule appears in the lower left-hand corner of each log sheet.

Dimensions of lumber.

Some of the lumber manufactured by the Red River Lumber Company was cut shy on dimensions. One-inch boards were sawed $\frac{15}{16}$″ in thickness, $\frac{6}{4}$″ boards were sawed $\frac{6}{4}$″ in thickness, 2″ x 4″ joists were sawed 1¾″ x 4″, $\frac{8}{4}$″ commons were sawed 1¾″ in thickness. Large timbers were sawed with an allowance of ¼″ in both directions for shrinkage. All boards over 8″ in width were sawed with an allowance of ¼″ for shrinkage. These deviations from true dimensions affect to some extent the total sawed out for each log, and therefore for each tree, and is one of the reasons why the mill over-run shown farther on is so uncommonly large.



Tree No. 038 Log No. 1 Spec. Jeffrey pine D.B.H. 30.2"

Log length 16' D.i.b. 22.2" D.o.b. [illegible]

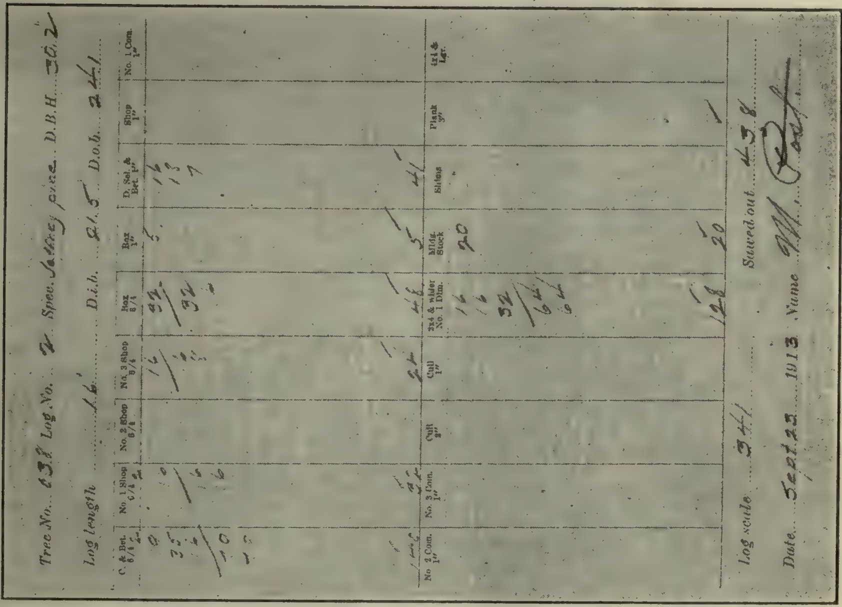
C. & Bet. 6/4	No. 1 Shop 6/4	No. 2 Shop 6/4	No. 3 Shop 6/4	Box 6/4	Box 1"	D. Sel. & Bet. 1"	Shop 1"	No. 1 Com. 1"
16 9 19 24 13 16 16 32 155 77.5					4	3 5 8 13 64		32
232.5					4	64		32

No. 2 Com. 1"	No. 3 Com. 1"	Cull 2"	Cull 1"	2x4 & wider No. 1 Dim.	Mldg. Stock	Shims	Plank 3"	4x4 & Lgr.
				32 16 16 64 64	12 24 8 57			
				128	57		6	

Log scale 344 Sawed out [illegible]

Date Sept 23 1913 Name [illegible]

PLATE IV.—Mill Sheet for Log No. 1, Tree No. 038.



Tree No. 038 Log No. 2 Spec. Jeffrey pine D.B.H. 30.2"

Log length 16' D.i.b. 21.5 D.o.b. 24.1

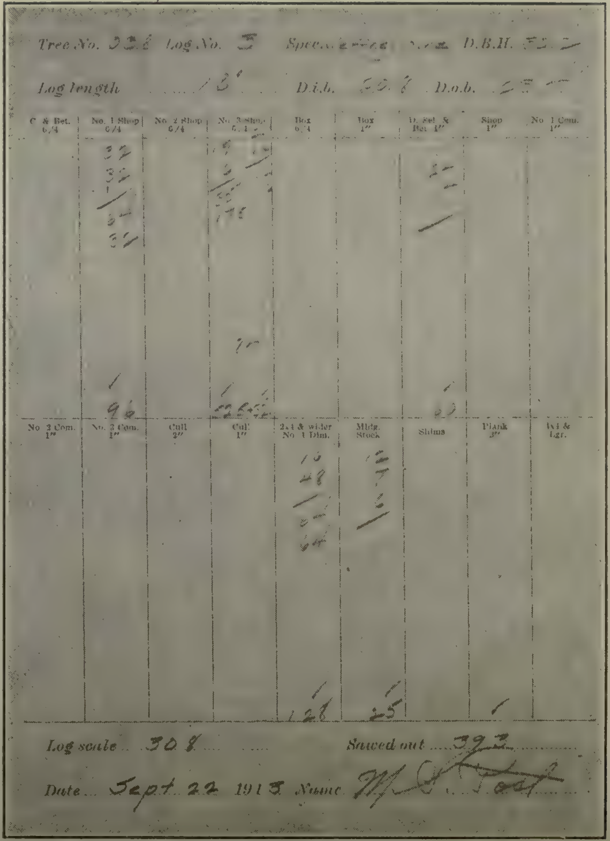
C. & Bet. 6/4	No. 1 Shop 6/4	No. 2 Shop 6/4	No. 3 Shop 6/4	Box 6/4	Box 1"	D. Sel. & Bet. 1"	Shop 1"	No. 1 Com. 1"
2 9 35 6 10 10	2 10 16 16		16 4 4	32 32 16	5	16 18 7		
146	32		24	48	5	41		

No. 2 Com. 1"	No. 3 Com. 1"	Cull 2"	Cull 1"	3x4 & wider No. 1 Dim.	Mldg. Stock	Shims	Plank 3"	4x4 & Lgr.
				16 16 32 64 64	20			
				128	20		✓	

Log scale 341 Sawed out 438

Date Sept 23 1913 Name W. Post

PLATE V.—Mill Sheet for Log No. 2, Tree No. 038.



Tree No. 038 Log No. 3 Spec. [illegible] D.B.H. [illegible]

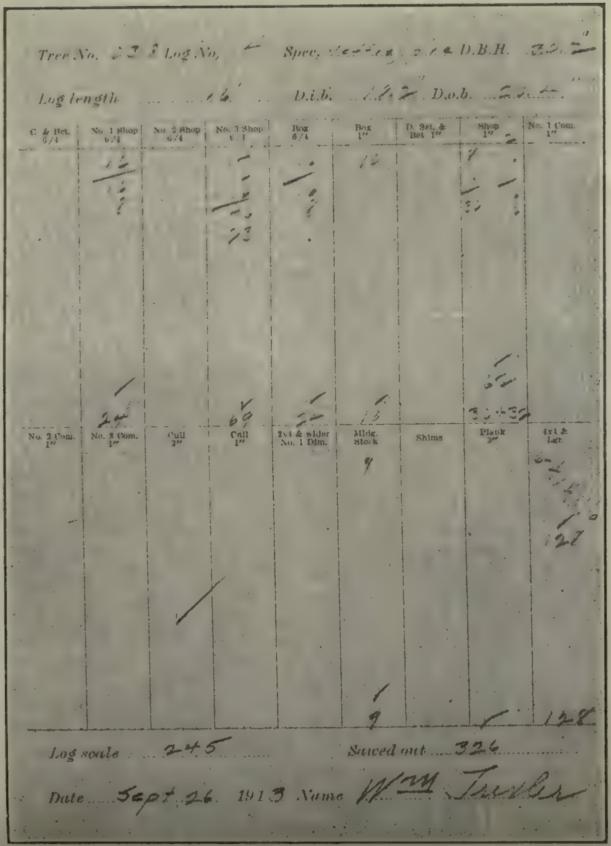
Log length 18' D.i.b. [illegible] D.o.b. [illegible]

C & Bet. 6/4	No. 1 Shop 6/4	No. 2 Shop 6/4	No. 3 Shop 6/4	Box 6/4	Box 1"	D. Sel. & Bet 1"	Shop 1"	No. 1 Com. 1"
	96							
No. 2 Com. 1"	**No. 3 Com. 1"**	**Cull 2"**	**Cull 1"**	**2x4 & wider No. 1 Dim.**	**Mldg. Stock**	**Shims**	**Plank 3"**	**4x4 & Lgr.**
				128	25			

Log scale 308 Sawed out 392

Date Sept 22 1913 Name [illegible]

PLATE VI.—Mill Sheet for Log No. 3, Tree No. 038.



Tree No. 038 Log No. 4 Spec. [illegible] D.B.H. [illegible]

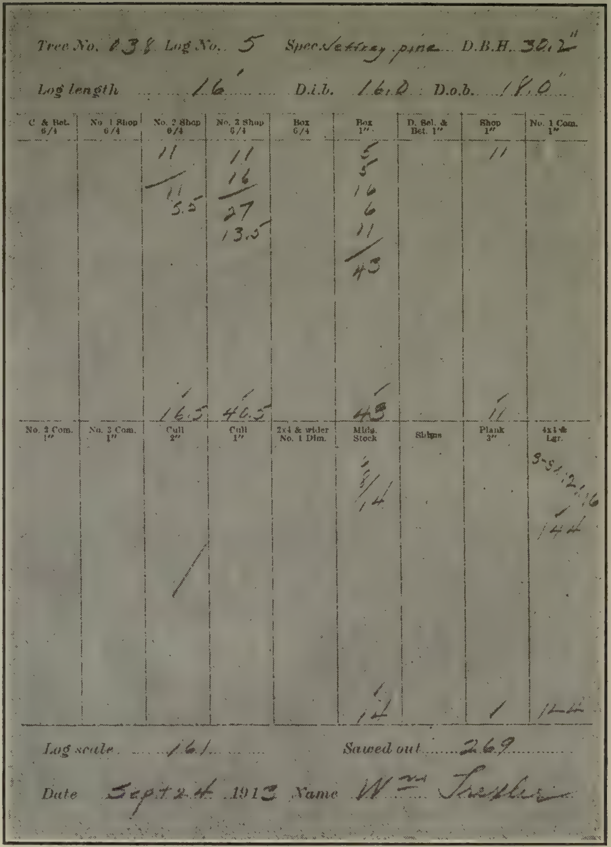
Log length 16' D.i.b. [illegible] D.o.b. [illegible]

C & Bet. 6/4	No. 1 Shop 6/4	No. 2 Shop 6/4	No. 3 Shop 6/4	Box 6/4	Box 1"	D. Sel. & Bet 1"	Shop 1"	No. 1 Com. 1"
	24		69		15			
No. 2 Com. 1"	**No. 3 Com. 1"**	**Cull 2"**	**Cull 1"**	**2x4 & wider No. 1 Dim.**	**Mldg. Stock**	**Shims**	**Plank 3"**	**4x4 & Lgr.**
					9			128

Log scale 245 Sawed out 326

Date Sept 26 1913 Name Wm Trexler

PLATE VII.—Mill Sheet for Log No. 4, Tree No. 038.



Tree No. 038 Log No. 5 Spec. Jeffrey pine D.B.H. 30.2"

Log length 16' D.i.b. 16.0 D.o.b. 18.0"

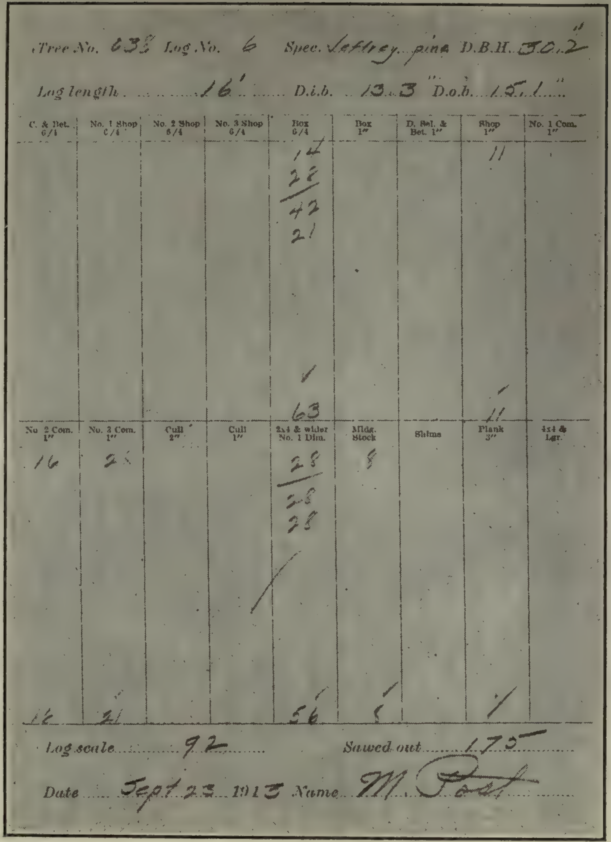
C. & Bet. 6/4	No. 1 Shop 6/4	No. 2 Shop 6/4	No. 3 Shop 6/4	Box 6/4	Box 1"	D. Sel. & Bet. 1"	Shop 1"	No. 1 Com. 1"
		11 11 5.5 16.5	11 16 27 13.5 40.5		5 5 16 6 11 43 43		11 11	

No. 2 Com. 1"	No. 3 Com. 1"	Cull 2"	Cull 1"	2x4 & wider No. 1 Dim.	Mldg. Stock	Shims	Plank 3"	4x4 & Lgr.
					3 3/14 14		1	9-9/12/16 144 144

Log scale 161 Sawed out 269

Date Sept 24 1913 Name Wm Tressler

Plate VIII.—Mill Sheet for Log No. 5, Tree No. 038,



Tree No. 038 Log No. 6 Spec. Jeffrey pine D.B.H. 30.2"

Log length 16' D.i.b. 13.3" D.o.b. 15.1"

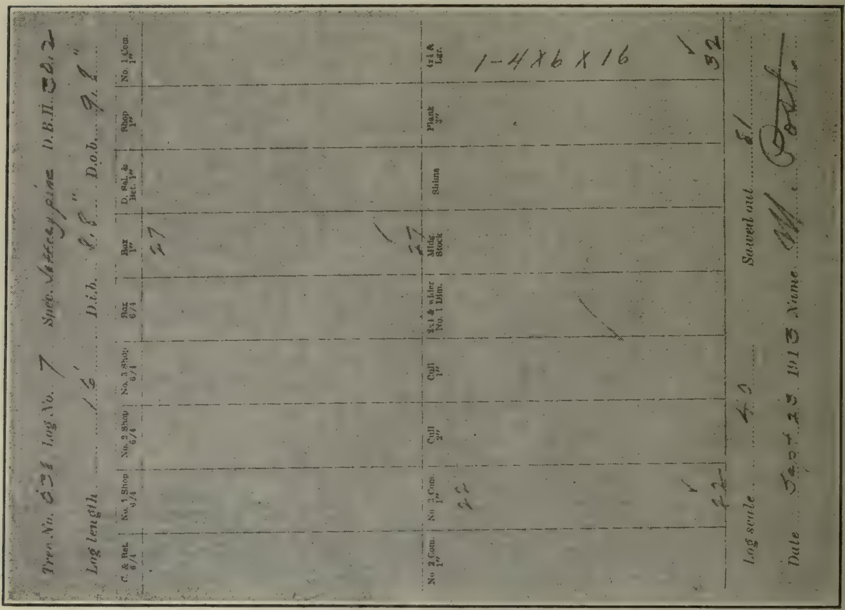
C. & Bet. 6/4	No. 1 Shop 6/4	No. 2 Shop 6/4	No. 3 Shop 6/4	Box 6/4	Box 1"	D. Sel. & Bet. 1"	Shop 1"	No. 1 Com. 1"
				14 28 42 21 63			11 11	

No. 2 Com. 1"	No. 3 Com. 1"	Cull 2"	Cull 1"	2x4 & wider No. 1 Dim.	Mldg. Stock	Shims	Plank 3"	4x4 & Lgr.
16 16	21 21			28 28 28 56	8 8		1	

Log scale 92 Sawed out 175

Date Sept 23 1913 Name M. Post

Plate IX.—Mill Sheet for Log No. 6, Tree No. 038.



Tree No. 038 Log No. 7 Spec. Jeffrey pine D.B.H. 30.2

Log length 16' D.i.b. 8.8" D.o.b. 9.1"

C. & Bet. 6/4	No. 1 Shop 6/4	No. 2 Shop 6/4	No. 3 Shop 6/4	Box 6/4	Box 1"	D. Sel. & Bet. 1"	Shop 1"	No. 1 Com. 1"
					27			
					✓ 27			

No. 2 Com. 1"	No. 3 Com. 1"	Cull 2"	Cull 1"	2x4 & wider No. 1 Dim.	Mldg. Stock	Shims	Plank 3"	4x4 & Lgr.
	22			✓				1-4x6x16
	✓ 22							✓ 32

Log scale 40 Sawed out 81

Date Sept 23 1913 Name W. Post

PLATE X.—Mill Sheet for Log No. 7, Tree No. 038.

GRADING RULES.

Eastern grading rules were used by the Red River Lumber Company, and during this mill scale study the grading was observed very closely by the writer so that a clear description of each grade as applied to the lumber on the live chains could be given.

It will be seen from the description of the various grades which follow that each of them, with the exception of 2″ x 4″ and wider, 4″ x 4″ and larger, and 3″ plank, specifies clearly lumber of a definite quality, their limitations being such that it is not possible to conscientiously crowd poor material into the upper grades. The grader will, of course, give lumber as high a mark as possible, since it is greatly to the interest of the company to have its good quality material graded as such. The rules given below do not prevent the good quality of lumber found in a log from being placed in a low grade, but they do prevent the poor quality from entering the high grades. Therefore, on the one hand, the grader makes his mark of quality as high as possible and, on the other, the grading rules bar him from placing inferior lumber in with the upper grades.

Description of Grades.

C. and better.

Sound material free from knots, pitch seams, wane and sap-stain, and true to dimensions. May be all sap-wood, all heart-wood, or any combination of the two. Dimensions may be: thickness, 5/4″, 6/4″, 8/4″ or 12/4″; width, anything over 8″. A very small amount of 5/4″, 8/4″ and 12/4″ stock was sawed. Fully 85 per cent of the stock was sawed 6/4″.

D. Select and better.

Sound material free from sap-stain, large pitch seams and wane, true to dimensions, occasional pin-knots allowed. Can be all heart-wood, all sap-wood, or any combination of the two. Dimensions may be: thickness, 1″; width, no restrictions.

Moulding stock.

Sound material, free from knots and sap-stain. Wane on one edge allowed. Must be all sap-wood. Edgings, except from shims, containing clear, sound sap-wood, free from stain, and of sufficient width are graded as moulding stock. Dimensions may be $\frac{5}{4}$″, $\frac{6}{4}$″ or $\frac{8}{4}$″; width, 8″ or below. Most of the moulding stock graded consisted of edgings from $\frac{6}{4}$″ C. and better and shop material.

No. 1 Shop.

Sound material, free from sap-stain, and true to dimensions, which can not be graded as C. and better, due to the presence of knots, pitch-seams and wane. The knots may be large, small, or of various sizes, or may be sound or decayed without affecting the grade so long as the material shows at least 75 per cent of clear cuttings. Dimensions may be: thickness, $\frac{5}{4}$″, $\frac{6}{4}$″ or $\frac{8}{4}$″; width, 8″ or over; $\frac{6}{4}$″ material usually sawed.

No. 2 Shop.

Sound material, free from sap-stain and true to dimensions, which can not pass as No. 1 Shop but which must contain at least 50 per cent of clear cuttings. Dimensions the same as for No. 1 Shop; $\frac{6}{4}$″ material usually sawed.

No. 3 Shop.

Sound material, free from sap-stain and true to dimensions, which can not pass as No. 2 Shop, but which must contain at least 25 per cent of clear cuttings. Dimensions the same as for No. 1 and No. 2 Shop; $\frac{6}{4}$″ material usually sawed.

Box.

Sound material, true dimensions, less than 12″ in width, which can not pass as No. 3 Shop, due to the presence of numerous knots, sap-stain or excessive wane. Dimensions may be: thickness, 1″, $\frac{5}{4}$″, $\frac{6}{4}$″ or $\frac{8}{4}$″; width, under 12″.

Shop 1″.

Sound material 1″ thick, free from sap-stain and true to dimensions. Grade about the same as No. 2 Shop. Dimensions may be: thickness, 1″; width, 8″ or over.

No. 1 Common.

Sound material 12″ or more in width, free from sap-stain and wane, and true to dimensions, which can not be graded as No. 1 Shop, due to numerous small, sound knots. This grade of material must be springy, heavy, and have all indications of fair strength. Dimensions may be: thickness, 1″ or $\frac{8}{4}$″; width, 12″ or over; 1″ x 12″ material usually sawed.

No. 2 Common.

Sound material 12″ or more in width, free from sap-stain and wane, and true to dimensions, which can not be graded as No. 1 Common due to large, sound knots being present. This grade of material must also show fair indications of strength. Dimensions the same as No. 1 Common.

No. 3 Common.

Sound material 12″ or more in width, free from sap-stain and wane and true to dimensions. This material is barred from No. 1 and No. 2 Common since it is light in weight and lacks the necessary springiness indicative of strength. Dimensions the same as for No. 1 and No. 2 Common.

Shims.

Sound material not true to dimensions. Poorly sawed lumber, thin in some places and thick in others. This grade includes lumber from all other grades except Culls. It was observed that shims, as a rule, were high grade material, cut from the outside of fair-sized logs. The sawyer apparently had better control of the sawing after the log had been squared. Shims may be of various sizes; dimensions not definite.

2″ x 4″ and wider.

Sound material 2″ thick and at least 4″ wide, true to dimensions and containing many small knots. Quality about the same as Box, No. 2 Common or No. 3 Common.

4″ x 4″ and larger.

Sound material 4″ thick and 4″ wide or larger, true to dimensions. Quality about the same as Box, No. 2 Common or No. 3 Common.

Plank 3″.

Sound material sawed 3″ thick and of various widths, true to dimensions and containing many small knots. Quality about the same as Box, No. 2 Common or No. 3 Common. Note: Some 3″ plank was sawed from the sap-wood of large logs and passed the grade of C. and better.

Culls.

Unsound material, and material containing many large, rotten knots or excessively cross-grained. In short, any lumber sawed which contains defects sufficient to bar it from all of the other grades. Dimensions: all sizes of stock sawed.

UTILIZATION.

At the time this study was made there could not have been a much closer utilization of forest products than that practiced by the Red River Lumber Company. The woods operations being very close to the mill made the cost of logging exceptionally low, thus making it profitable to handle logs of exceedingly low grade. If a log from a windfall was believed to contain 10 per cent sound material, it was sent to the mill, and logs from the tops of immature trees measuring not over four or five inches in diameter inside bark were also milled. The stumps of all trees were cut very low. The company's orders to its falling crews in this regard were to cut all stumps under eighteen inches in height, measuring from the ground to the saw cut. A very small per cent of the merchantable volume was lost, due to breakage in falling, since the land upon which the trees grew was exceptionally level, also since broken sections measuring only seven or eight feet in length were used.

It probably would have been next to impossible to have sawed more lumber from the logs after they reached the mill than was sawed by this company. The slabs were cut as thin as possible, and short lengths were sawed where the taper was great enough to permit it. Edgings of clear straight grained material were utilized and graded as moulding stock, and in a great many cases considerable wane was left on the end of boards coming from the small end of logs.

The milling machinery was of modern type throughout. Therefore, the minimum amount of waste in the form of sawdust resulted, and, lastly, some of the lumber manufactured was cut shy on dimensions.

The above facts account for the enormous mill over-run based on the Spaulding Log Rule, which averaged for all lumber cut each month between 35 and 40 per cent.

F. O. B. PRICES.

The following F. O. B. prices for the various grades of lumber sawed at the Red River Lumber Company's mill were in vogue during the fall of 1913 and winter of 1914, and were used in this report for all value determinations:

	Per 1,000 board feet
C. and better, 6/4″	$32 00
D. Select and better, 1″	25 00
Moulding stock	30 00
No. 1 Shop, 6/4″	27 00
No. 2 Shop, 6/4″	18 00
No. 3 Shop, 6/4″	13 00
Box 6/4″	11 00
Box 1″	9 00
Shop 1″	18 00
No. 1 Common	22 00
No. 2 Common	18 00
No. 3 Common	15 00
Shims	7 00
2″ x 4″ and wider	15 00
4″ x 4″ and larger	15 00
Plank 3″	15 00
Culls	7 00

PART II. GRAPHIC ANALYSIS.

Part II of this publication is a detailed graphic analysis of all the woods and mill data pertaining to the volume, value and growth of immature and mature western yellow pine; resulting from field work described in Part I.

The methods of graphic analysis afford, without doubt, the most authentic means of determining the underlying principles and average values from a large amount of data. Average values obtained by such methods depend not only upon the arithmetical averages of the parts which make up the whole, but each part in turn depends upon every other part. Values and underlying principles determined by graphics from a large number of observations are dependent upon the majority of observations made, and are not influenced to any great extent by erratic values, which are usually the result of some error in observation. Such errors as a rule are compensative, and the principal tendency they have is to enlarge the field of variation. They do not affect the curve of averages such as would be located by one of skill and experience.

Compensative errors may occur in large numbers without any influence upon the final results. They may, however, make the work more difficult and obscure, but so long as they are well within the minority their influence should never reach the skilfully located locus of averages.

Accumulative errors have an entirely different effect. Their influence can not be eliminated from the final determinations unless a proper correction based upon the known errors be applied. Their effect will be to either raise or lower the curve of averages with an accompanying change of its slope. Such errors are introduced usually by using incorrect measuring instruments, such as a scale with divisions marked inches and tenths of inches which are a little greater or a little less than inches or tenths of inches, or by using incorrectly adjusted calipers, etc. Such errors are easily prevented by standardizing all instruments and scales before putting them into use, and then keeping them in good condition.

Still another form of error may creep in which is neither compensative nor accumulative, but which holds constant for each individual observation. This form also can not be eradicated by methods of graphics, unless known and the proper correction applied. It may be caused by measuring from a point on a tape which is not a true zero point, or by using a tape which has been spliced, such that beyond the splice it is longer or shorter than it should be. The effect upon the curve of averages is to raise or lower it by a constant amount without changing the slope. It is an error which should never enter into carefully performed work.

Notwithstanding the great advantages of graphics, it is a very poor method for an inexperienced person to use, since many inconsistencies may result. For instance, it is very possible to establish a set of values which absolutely contradict another set, and both sets be based upon the same original data. This may result from changing from one variable as the basis of comparison to another.

In the following graphic analysis, which embodies all data pertaining to this study, the variable chosen as the dependent variable is diameter breasthigh in inches. With but one exception (age-identification relations, which are based on age) it has been used throughout as the basis of comparison, and a complete analysis based upon it has been made for whole trees, butt logs and top logs, with the object in view to show both quantity and quality of the whole trees, of the butt logs, or best part of the tree, and of the top logs, the poorest part of the tree.

The complete data for each individual tree, as shown in Plates II to X were first assembled, each tree having a woods sheet, a stem analysis sheet, and as many mill sheets as there were logs in the tree. These assembled data, representing nine hundred and nineteen trees in all, were then divided, according to the identification made in the woods into two groups; typical yellow pine forming the one, which proved to be mature yellow pine; and bull pine or blackjack, which proved to be immature yellow pine, forming the other. There was a total of five hundred and seven immature, and four hundred and twelve mature trees. A complete analysis was made separately of each group, and the results have been averaged by means of curves and arranged on opposite pages of this publication so that a comparison might be easily followed. The trees of each group were arranged in classes, according to diameter breasthigh measurements, such that all trees ranging from 19″ to 20.9″, inclusive, formed the 20″ diameter class, and all trees ranging from 21.0″ to 22.9″, inclusive, formed the 22″ diameter class, and so on. Corresponding determinations of each diameter class were then added together and the arithmetical averages obtained by dividing the sums in each case by the total number of trees in the class.

Butt logs and top logs from immature and mature trees were analyzed in a similar manner, and the results averaged and arranged on opposite pages the same as for whole trees.

The original determinations averaged for each diameter class were as follows:

Clear length.
Merchantable length.
Total height.
Diameter of last log used.
Thickness of bark.
Height of stump.
Age.

Total volume in cubic feet inside bark from stump to height where the tree is 6″ in diameter outside bark.

Total volume in board feet as shown by the Spaulding Log Rule.

Total volume in board feet actually "sawed out" at mill.

Total volume of each grade in board feet contained in each tree actually "sawed out" at mill.

The number of trees forming each diameter class for the immature were as follows:

20″ class	12 trees
22″ class	39 trees
24″ class	67 trees
26″ class	92 trees
28″ class	96 trees
30″ class	65 trees
32″ class	58 trees
34″ class	30 trees
36″ class	28 trees
38″ class	9 trees
40″ class	9 trees
42″ class	2 trees
Total	507 trees

For the mature as follows:

20″ class	6 trees
22″ class	9 trees
24″ class	16 trees
26″ class	33 trees
28″ class	41 trees
30″ class	33 trees
32″ class	53 trees
34″ class	66 trees
36″ class	48 trees
38″ class	44 trees
40″ class	28 trees
42″ class	20 trees
44″ class	11 trees
*46″ class	2 trees
*48″ class	1 tree
*50″ class	1 tree
Total	412 trees

Therefore all diagrams for immature yellow pine in this publication, showing a relation existing between diameter breasthigh and some other variable, are based upon average points plotted, from left to right, with weights: 12, 39, 67, 92, 96, 65, 58, 30, 28, 9, 9, and 2 trees, respectively.

In like manner, all diagrams for mature yellow pine are based upon average points plotted from left to right, with weights as follows: 6, 9, 16, 33, 41, 33, 53, 66, 48, 44, 28, 20, and 11 trees.

The following symbols have been used in connection with the diagrams constructed to indicate relations existing between the various determinations made.

---

*Not used in the final analysis.

Let a = the average volume in board feet of 6/4″ C. and Better lumber contained in an immature tree D inches in diameter breasthigh.

Similarly, let b = Moulding Stock.

c = No. 1 Shop, 6/4″.
d = D. Select and Better, 1″.
e = No. 1 Common, 1″.
f = No. 2 Common, 1″.
g = Shop, 1″.
h = No. 2 Shop, 6/4″.
i = Shims.
j = Box, 1″.
k = Culls.
l = Box 6/4″.
m = No. 3 Shop, 6/4″.
n = No. 3 Common, 1″.
o = Plank 3″.
p = 4″ x 4″ and larger.
q = 2″ x 4″ and wider, No. 1 Dim.
D = Total volume in cubic feet inside bark from the stump to a height where the tree is 6″ in diameter outside the bark.
As = Total volume in board feet, as shown by the Spaulding Log Rule.
A = Total volume in board feet of lumber of all grades "sawed out" at mill.
Av = Volume of high grade lumber.
Bv = Volume of intermediate grade lumber.
Cv = Volume of low grade lumber.

Then $a + b + c + \text{-------} o + p + q = A$, total volume in board feet sawed out at mill.

$a + b + c + d = Av$, high grade.
$e + f + g + h + i = Bv$, intermediate grade.
$j + k + l + m + n + o + p + q = Cv$, low grade.
$Av + Bv + Cv = A$.

$\frac{100\ (a + b + c + d)}{A} = \frac{100\ Av}{A} = Ap$, per cent of high grade lumber sawed out.

$\frac{100\ (e + f + g + h + i)}{A} = \frac{100\ Bv}{A} = Bp$, per cent of intermediate grade lumber sawed out.

$\frac{100\ (j + k + l + m + n + o + p + q)}{A} = \frac{100\ Cv}{A} = Cp$, per cent of low grade lumber sawed out.

$Ap + Bp + Cp = 100\%$.

$.032a + .030b + .027c + .025d = Aval$, value in dollars and cents of Av, the high grade lumber produced.

$.022e + .018f + .018g + .018h + .007i = Bval$, value in dollars and cents of Bv, the intermediate grade lumber produced.

$.009j + .011k +$ --------- $.015q = Cval$, value in dollars and cents of Cv, the low grade lumber produced.

$Aval + Bval + Cval = B$, value in dollars and cents per tree.

$\frac{1000\,B}{A} = C$, value per 1000 board feet per tree.

The above symbols are also used with a subscript "1" attached to indicate similar relations for mature trees; with a subscript "1" and prime attached, to indicate similar relations for butt logs of mature trees; with a subscript "1" and a double prime attached, to indicate similar relations for top logs from mature trees. To illustrate:

a stands for the average volume in board feet of C and Better lumber contained in an immature tree D inches in diameter breasthigh.

a' stands for the average volume in board feet of C and Better lumber contained in a 16′ butt log from an immature tree D inches in diameter breasthigh.

a'' stands for the average volume in board feet of C and Better lumber contained in the last log used from an immature tree D inches in diameter breasthigh.

a_1, a_1', and a_1'' stand for similar relations for mature yellow pine.

Symbols appear in lower right-hand corner of each diagram.

FOR WHOLE TREES.

Age—Identification Relations.

Trees increase in diameter and height as they become older, and the rate of increase is dependent upon a great many influencing factors not always apparent to the closest observer. Trees of the same species may have a wide range in rate of growth, such that the age can not be judged by their size. It may be that the smallest tree in a group ranging in size from twenty to forty inches in diameter breasthigh is the oldest of that group, and the forty-inch tree the youngest. Some yellow pine trees measuring over forty inches in diameter have proved to be less than two hundred years old, whereas age determinations have shown trees of half that diameter to be over four hundred years of age.

The outward appearances of such trees are, however, very different. The large ones which may be comparatively young have a dark, thick, rough bark, numerous small limbs extending well down into the middle third and a cone-shaped top, whereas the small ones, which may be about twice as old, have a light colored rather thin, smooth bark, furrowed longitudinally and horizontally, forming plates which are comparatively smooth. All live limbs are very large and usually all above the middle third. The top is generally dome-shaped.

The age of yellow pine trees, which have grown under conditions similar to those existing in Lassen County, can be determined from outward appearances much closer than from height and diameter measurements. Figs. 3 and 4 show that the immature trees merge into a stage where the outward appearances are as much like the mature as the immature, and finally into the ages where the characteristics of the immature tree have vanished. The change in life, as this may be termed, averages two hundred and sixty-five years.

In Forest Service Bulletin No. 125, page 20, it is shown that the maximum periodic annual growth of yellow pine is obtained at two hundred and sixty years. That is, up till this age they have an accelerated growth, and lay on more wood each year than the year previous. After two hundred and sixty years the growth is a retarded one, and the volume of wood formed each year is a decreasing factor.

It is interesting to note that the change in life occurs at two hundred and sixty-five years, which is about the same age that the prime of life is reached, as shown by a separate investigation.

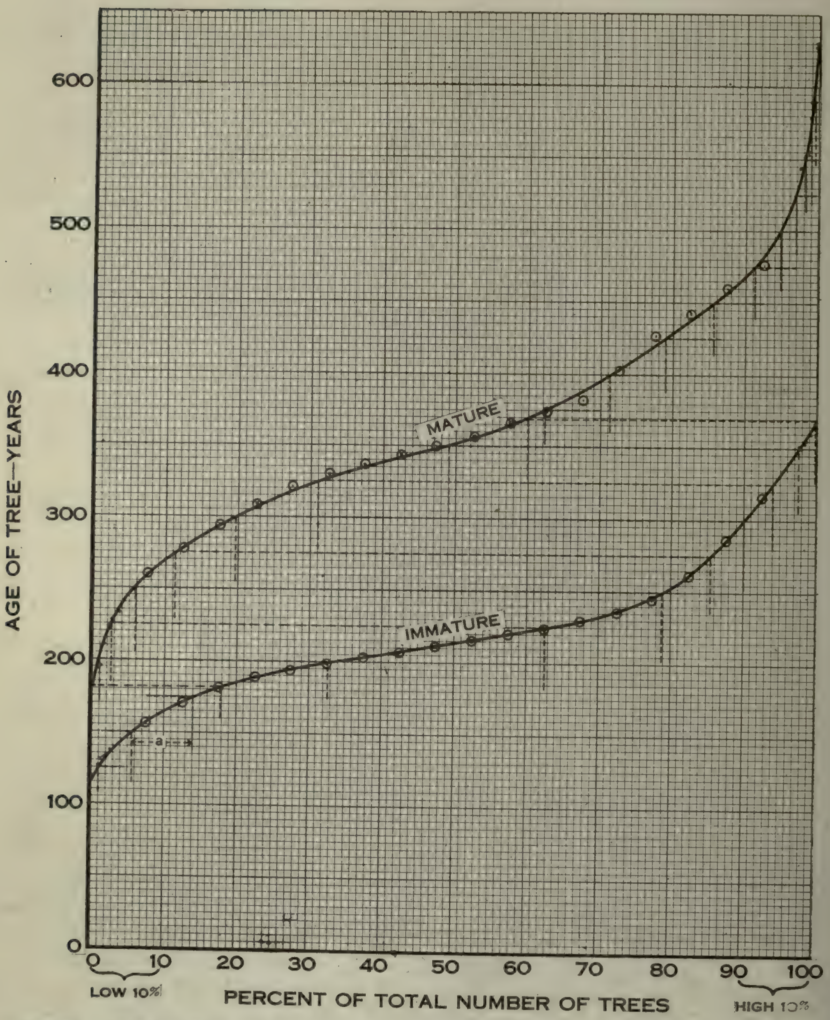


FIG. 1.—The relation of age to outward appearances. The bottom curve marked "immature" is based upon 507 trees, which were identified as "bull pine" (or "black-jack"), while standing. This curve was constructed as follows: (*a*) Data sheets were arranged in order of age from the youngest to the oldest tree. (*b*) Sheets were then divided into groups, each representing five per cent of the total number of trees. (*c*) The average of each of these groups were then plotted in their respective order. (*d*) Individual trees were plotted for the lowest five per cent and also for the highest five per cent. The top curve marked "mature" is based upon 412 trees identified as typical yellow pine, and was constructed the same as the curve marked "immature."

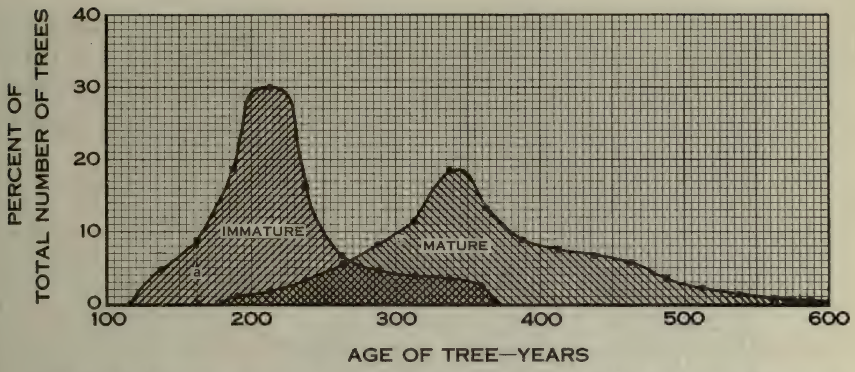


FIG. 2.—A diagram obtained directly from Fig. 1. The black points on the boundary show the per cent of total number of trees falling within periods of twenty-five years. For instance; the ordinate marked (*a*) indicates that nine per cent of all of the trees measured and identified as "bull pine" (immature) fell between 150 and 175 years. Ordinate (*a*) was plotted directly from Fig. 1, as indicated in that figure. All other ordinates were plotted in a similar manner.

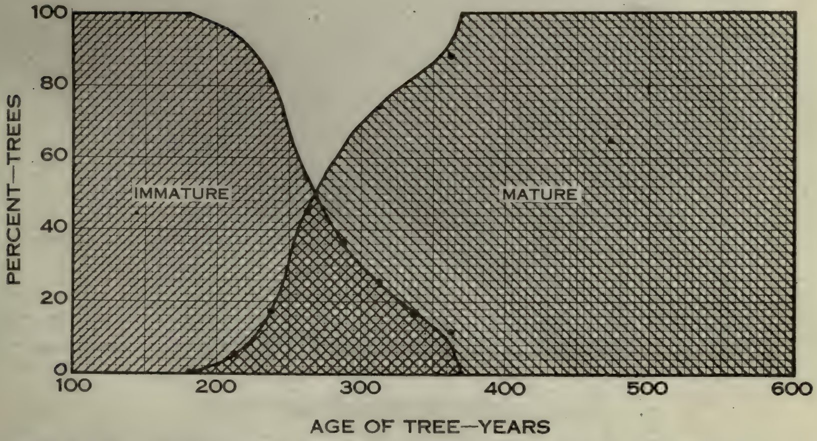


FIG. 3.—A diagram obtained directly from Fig. 2, and based upon the per cent of identifications of "bull pine" (immature) and typical yellow pine (mature), occurring at different ages. The lapping over of the two portions of the diagram indicates the ages at which maturity is reached; also, the per cent of total number of trees maturing at different ages.

Dimensions.

The following curves show the average dimensions of immature and mature trees of different diameters:

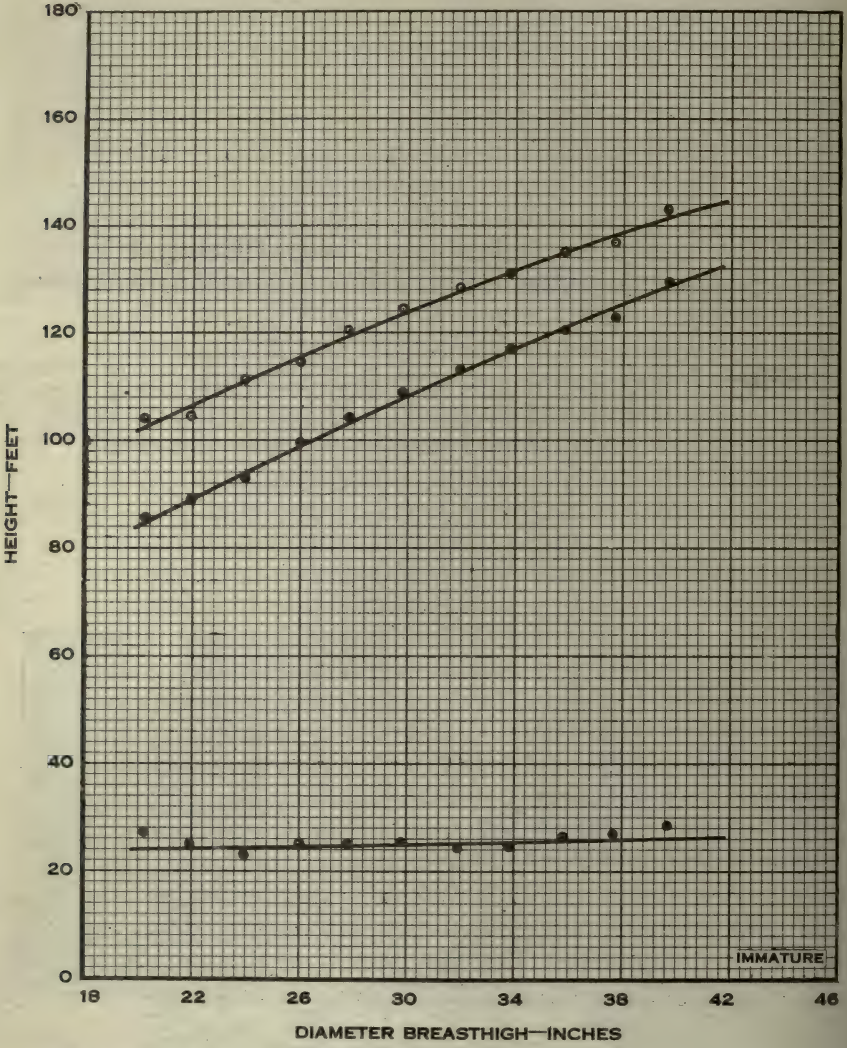


FIG. 4.—Curves showing average values for clear length, merchantable length, and total height, of immature western yellow pine trees, different diameters breasthigh.

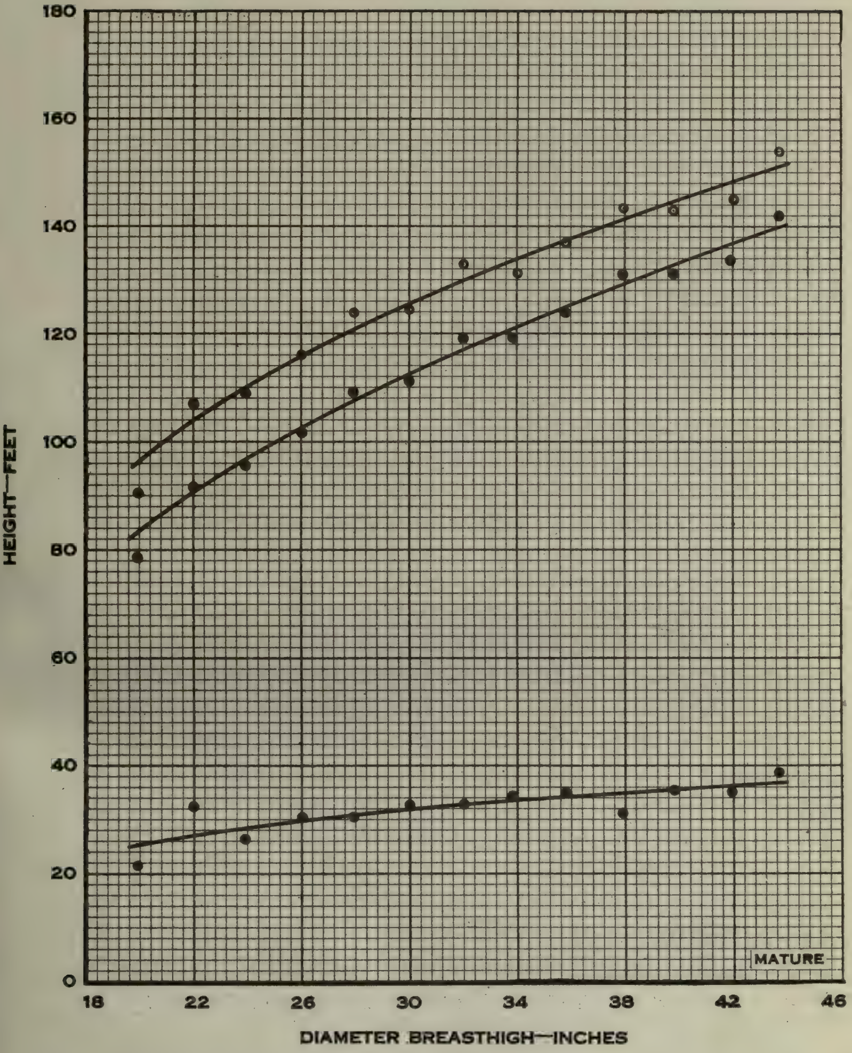


FIG. 5.—Curves showing average values for clear length, merchantable length, and total height, of mature western yellow pine trees of different diameters breasthigh.

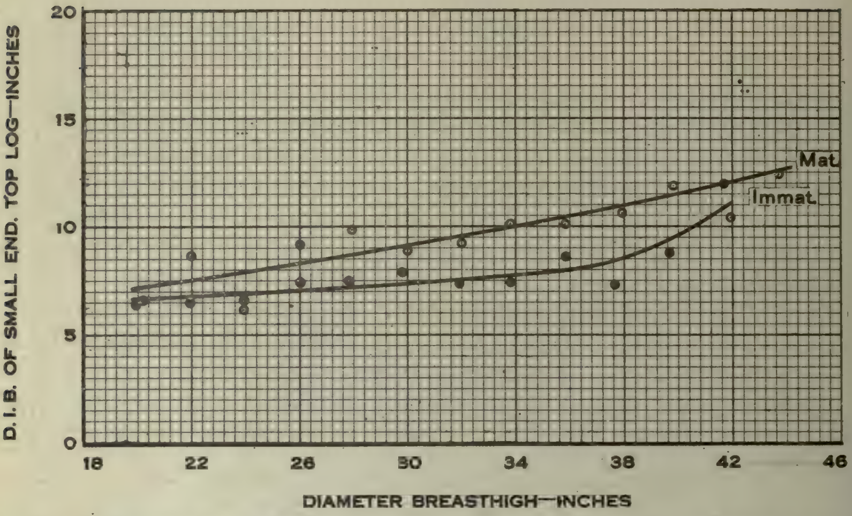


FIG. 6.—Curves showing average diameter inside bark at small end of last log used from immature and mature western yellow pine trees of different diameters breast-high.

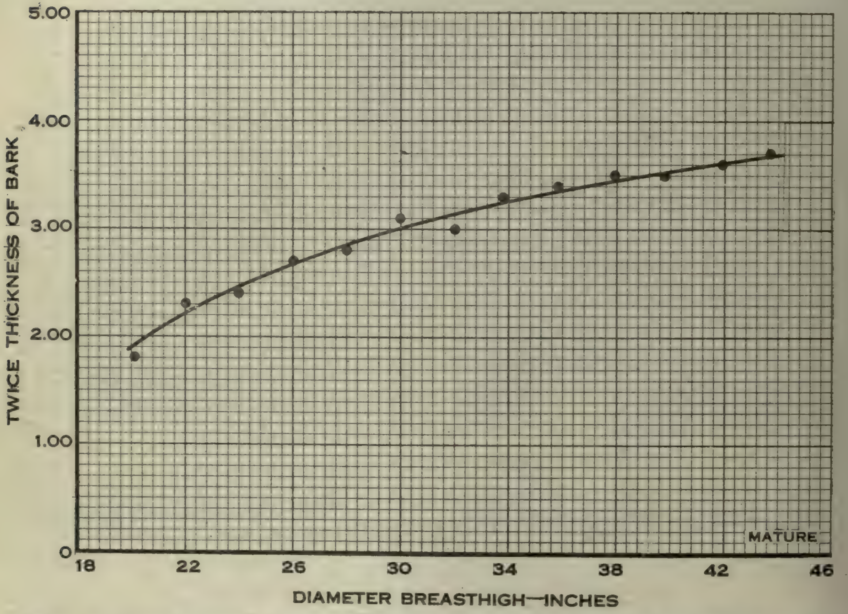


FIG. 7.—Curve showing average values for twice thickness of bark at the top of 16′ butt logs from mature western yellow pine trees of different diameters breasthigh.

Form.

By the "form" of a tree is meant the shape of the bole, or stem. Trees of the same species and of different diameters breasthigh necessarily do not have stems of the same shape. It may be that a large tree will have a very small taper in the lower third, a slightly greater one in the middle third and an exceedingly large taper in the top third. Or it may be that the taper will be rather uniform at all points along the stem. Trees with increasing taper, such as cited in the first case, have boles which approach very closely the shape of a paraboloid of revolution, where trees with a practically uniform taper approach more closely the shape of a cone. Young trees, as a rule, are of the latter form. Old trees are likely to be filled out more than the young, and therefore approach more closely the shape of a paraboloid.

Each layer of wood formed during the growth of a tree is not uniform in thickness at different heights from the ground. The wood of each annual layer as a rule is a little thicker in the top third of the stem than it is in the bottom third. This is very noticeable in trees which are nearing maturity. The annual layers formed by western yellow pine trees at this stage of life are a great deal thinner at the diameter breasthigh than in the top third of the bole. Such trees are "filling out"; their bark is also shedding faster than it is formed, and it is very possible for the diameter breasthigh measurement to hold constant or even decrease while the volume is gradually increasing. Fullness of bole or form is usually expressed in terms of "form factors."

Form factors.

A form factor for a given tree may be the volume of that tree in cubic feet divided by the volume of a cylinder, with dimensions equal to the breasthigh measurement and height of the tree. If the factor for a certain tree is .333, it means that the volume is equal to one-third of the cylinder to which the tree is compared. If the factor is .500, the tree has half the volume of the cylinder, and so on.

Tables 11 and 12, page 138, show form factors for the merchantable portions of both immature and mature yellow pine trees. It will be observed that the factors worked out for immature trees are larger for the small trees than for the large ones. This is due to the effect of "butt swelling." Since for small trees the breasthigh measurement, which is taken at four and one-half feet above the ground in all cases, is well above the enlarged portion of the butt. In large trees the effect of "butt swelling" enters in quite noticeably, thus giving a large breasthigh measurement and therefore larger cylinder for comparison. This reduces the form factor. It will be seen in Table 12, page 139, that the form factors for mature trees of different sizes are practically constant, and that the values in all cases are greater than for the immature, which shows that the former are filled out more than the latter and therefore contain more wood for a given diameter measurement.

Volume.

Curves showing average values for total volume in board feet, also in cubic feet, contained in merchantable portion of immature western yellow pine trees of different diameters breasthigh.

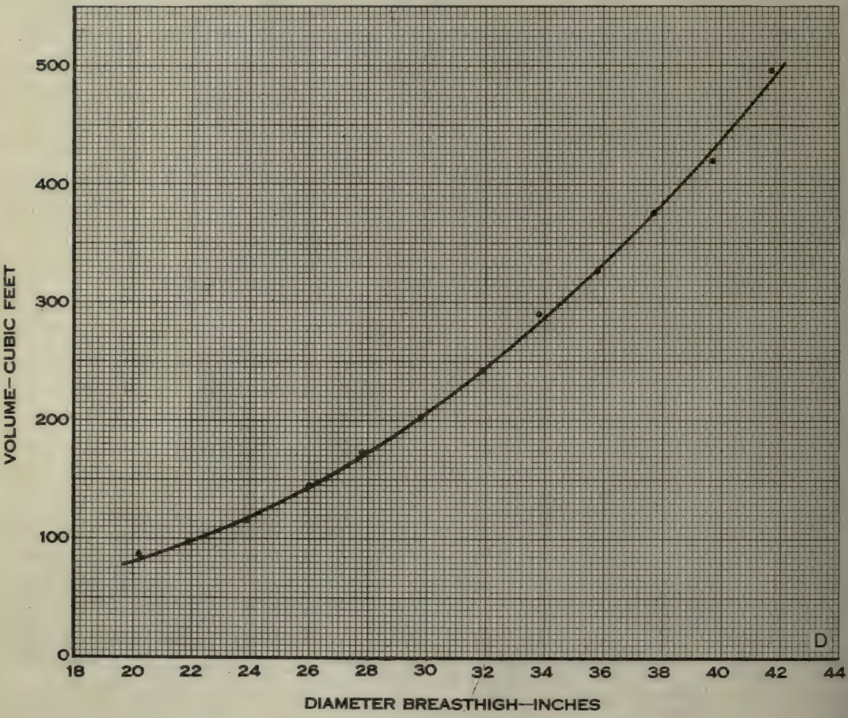


FIG. 8.—Total volume in cubic feet inside bark from the stump to a height where the tree is 6″ in diameter outside the bark.

Curves showing average values for total volume in board feet, also in cubic feet, contained in merchantable portion of mature western yellow pine trees of different diameters breasthigh.

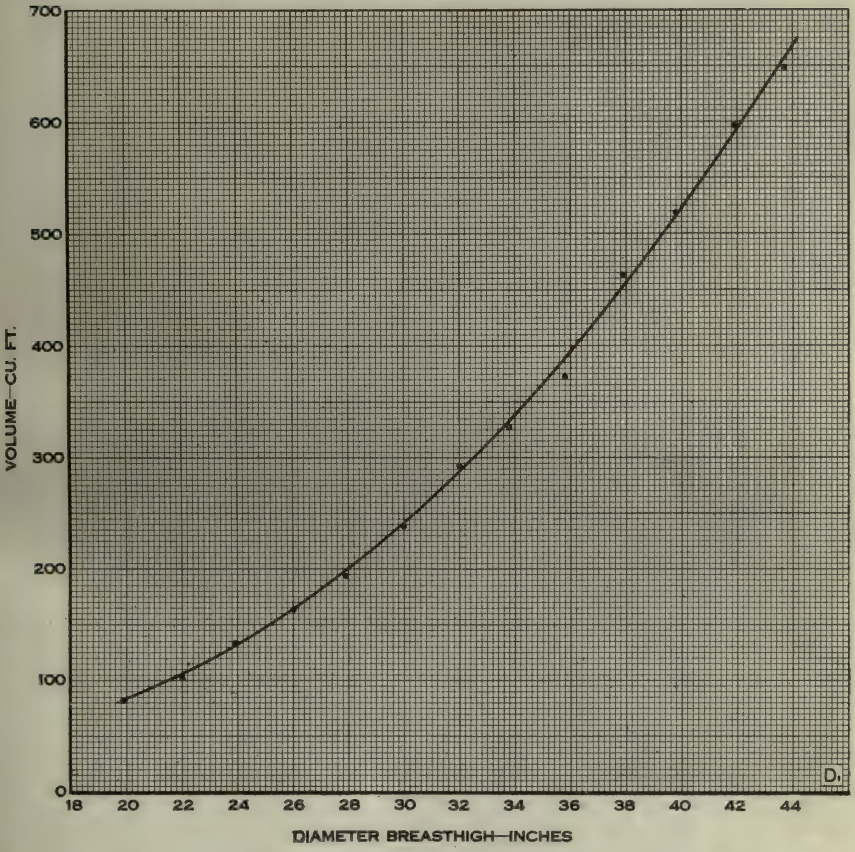


FIG. 9.—Total volume in cubic feet inside bark from the stump to a height where the tree is 6" in diameter outside the bark.

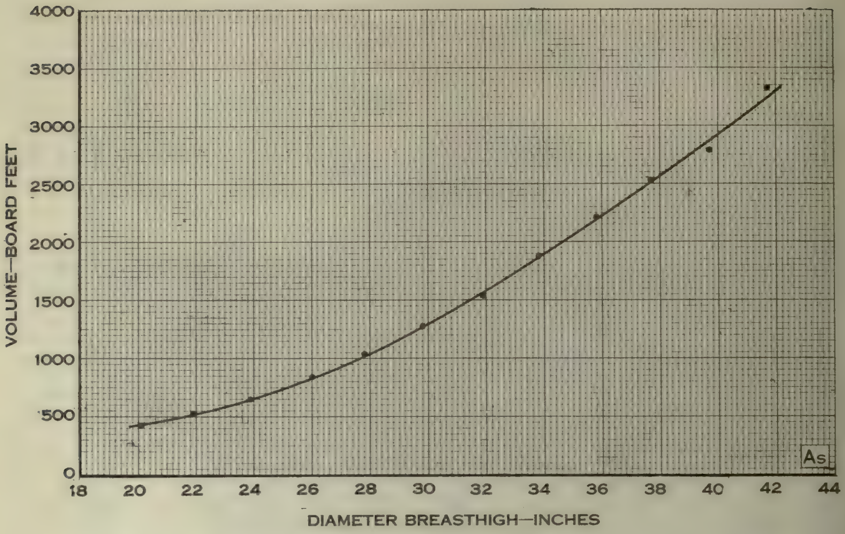


FIG. 10.—Total volume in board feet, as shown by the Spaulding Log Rule.

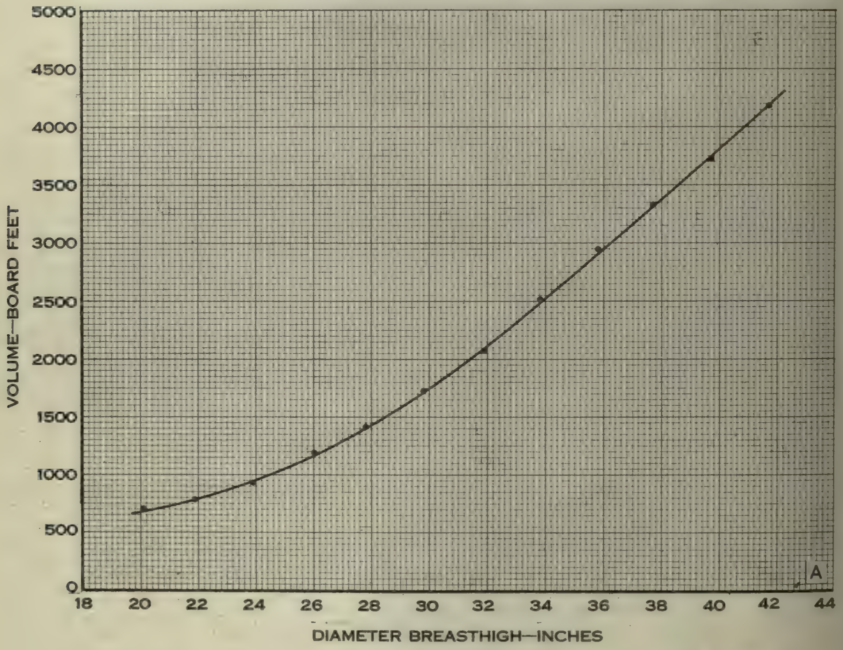


FIG. 11.—Total volume in board feet actually "sawed out" at mill.

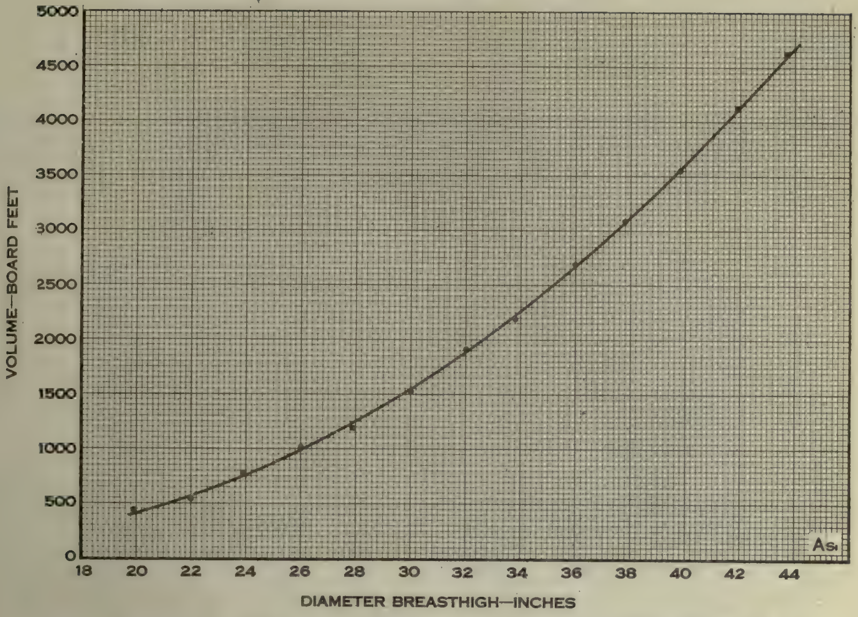


FIG. 12.—Total volume in board feet, as shown by the Spaulding Log Rule.

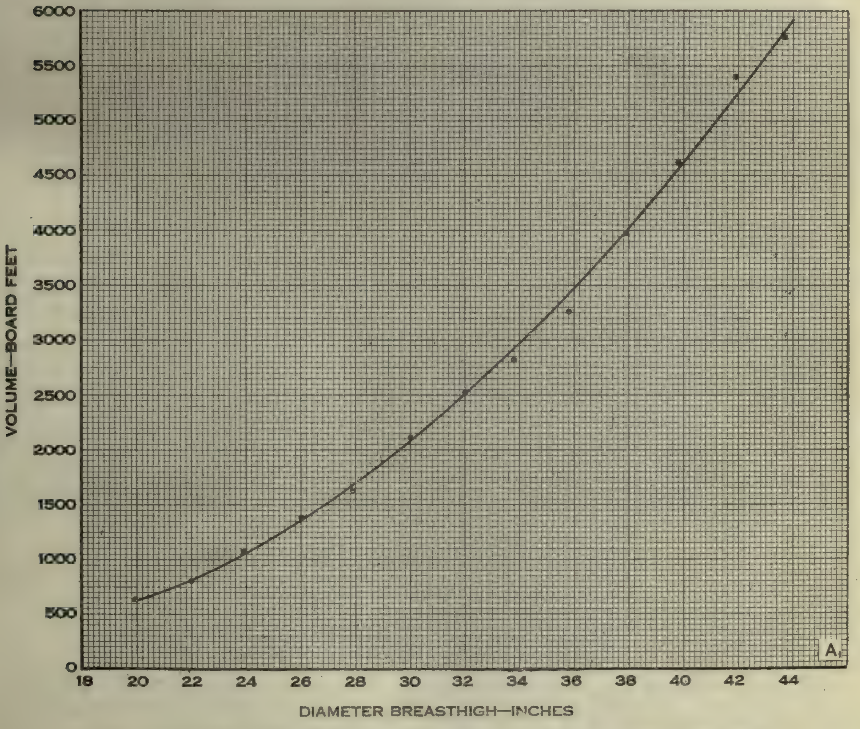


FIG. 13.—Total volume in board feet actually "sawed out" at mill.

Curves showing average volume in board feet of each grade actually "sawed out" at mill, from merchantable portion of immature western yellow pine trees of different diameters breasthigh.

High Grades Sawed From Immature Trees.

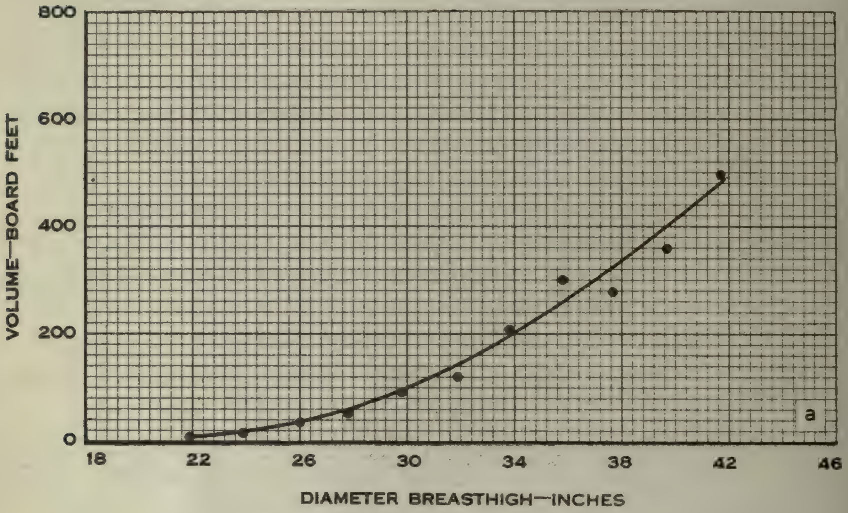


FIG. 14.—C. and Better, 6/4".

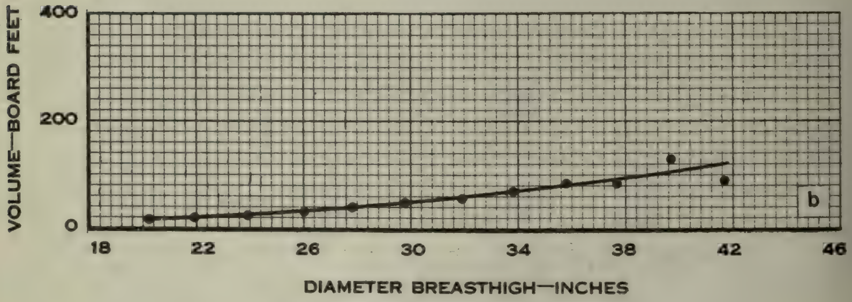


FIG. 15.—Moulding stock.

Curves showing average volume in board feet of each grade actually "sawed out" at mill, from merchantable portion of mature western yellow pine trees of different diameters breasthigh.

High Grades Sawed From Mature Trees.

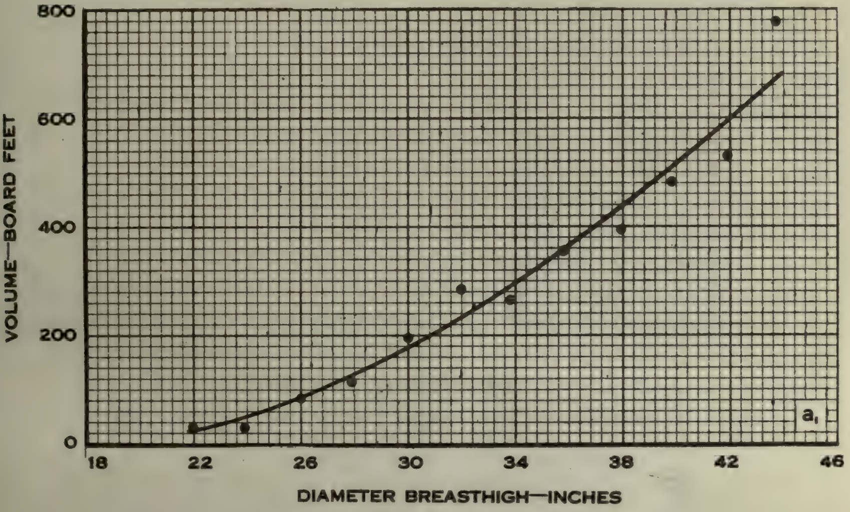


FIG. 16.—C. and Better, 6/4"

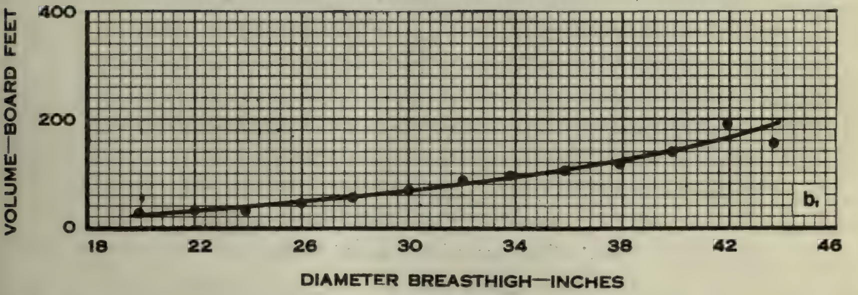


FIG. 17.—Moulding stock.

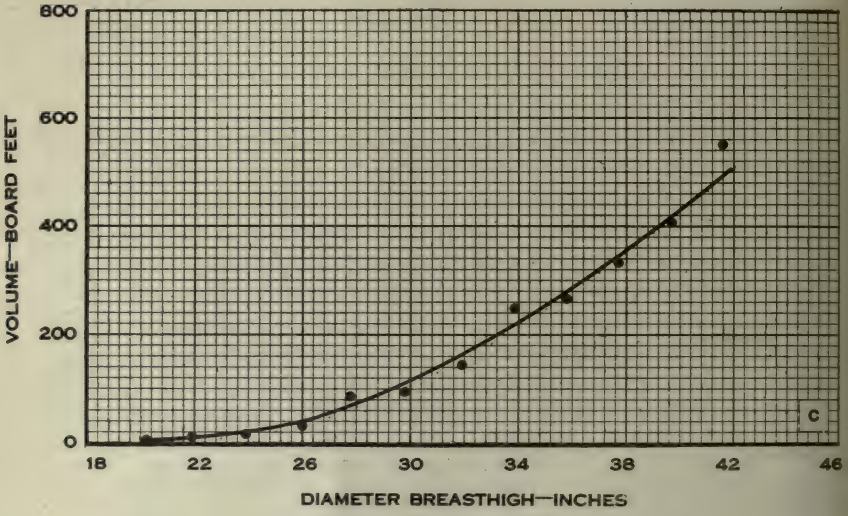


FIG. 18.—No. 1 Shop, 6/4″.

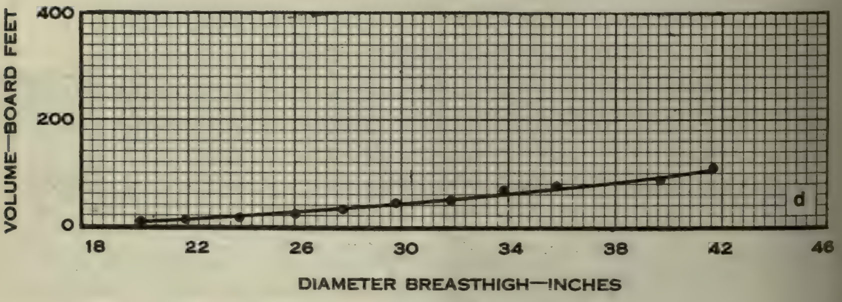


FIG. 19.—D. Select and Better, 1″.

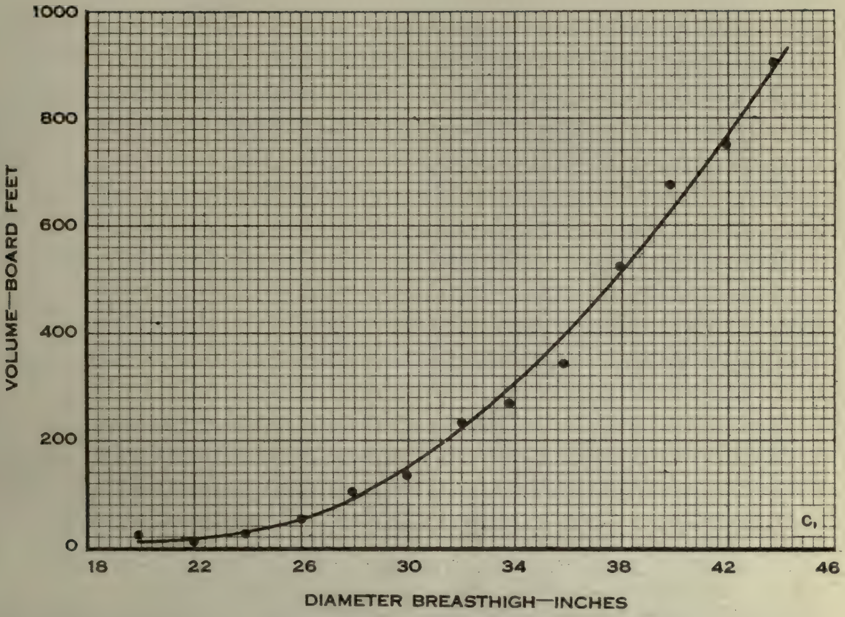


FIG. 20.—No. 1 Shop, 6/4″.

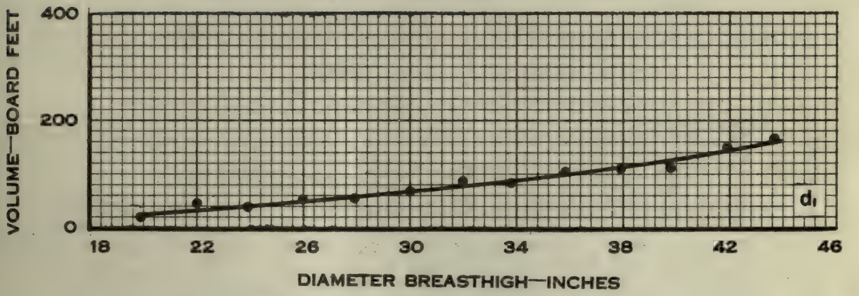


FIG. 21.—D. Select and Better, 1″.

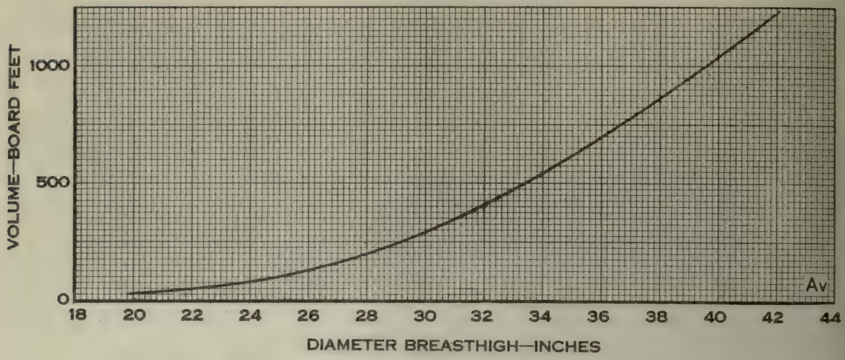


FIG. 22.—Total of high grades sawed from immature trees.

$$a + b + c + d = Av.$$

Intermediate Grades Sawed From Immature Trees.

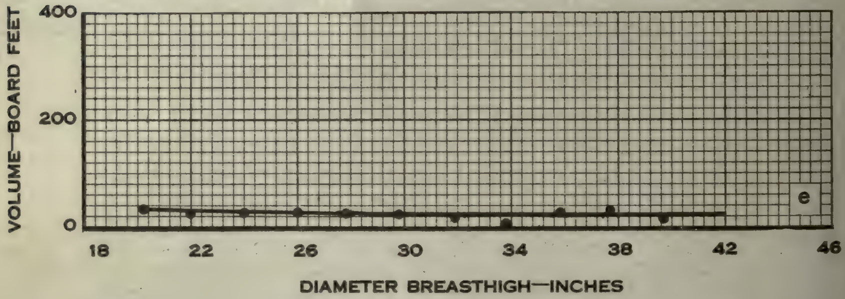


FIG. 23.—No. 1 Common, 1″.

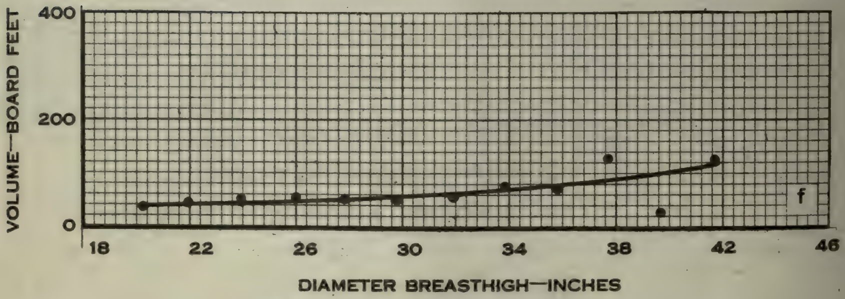


FIG. 24.—No. 2 Common, 1″.

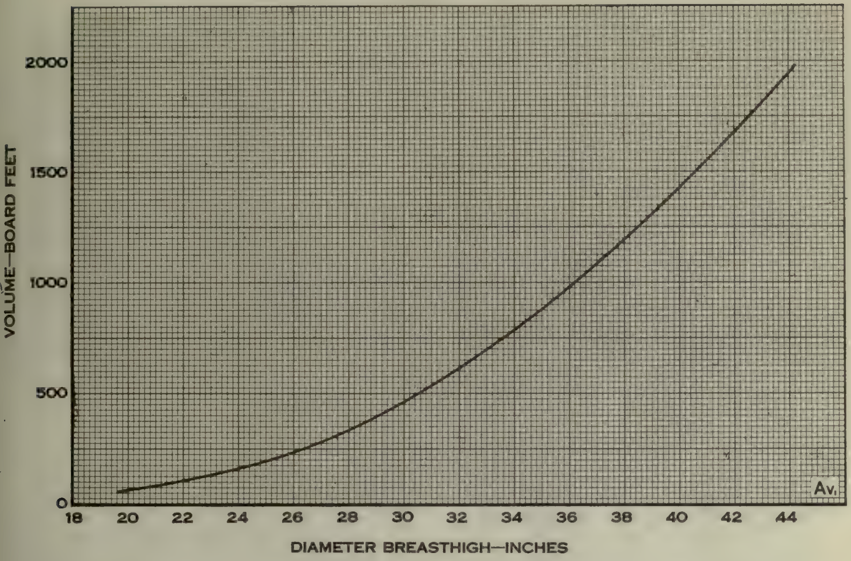


FIG. 25.—Total of high grades sawed from mature trees.

$$a_1 + b_1 + c_1 + d_1 = Av_1.$$

Intermediate Grades Sawed From Mature Trees.

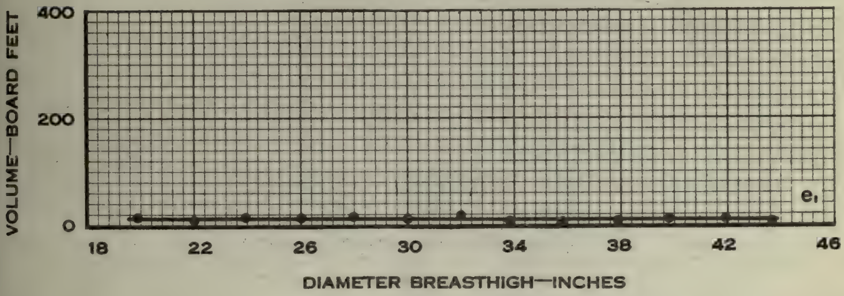


FIG. 26.—No. 1 Common, 1″.

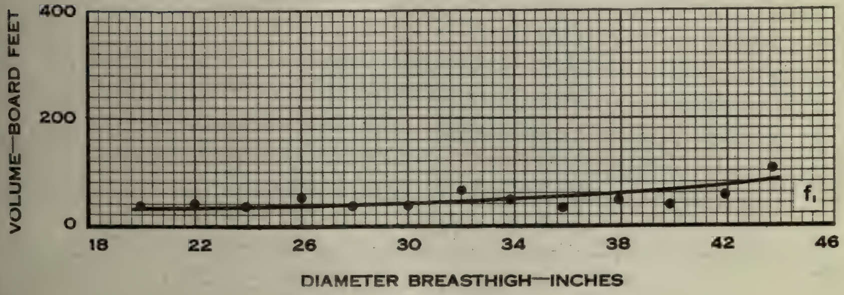


FIG. 27.—No. 2 Common, 1″.

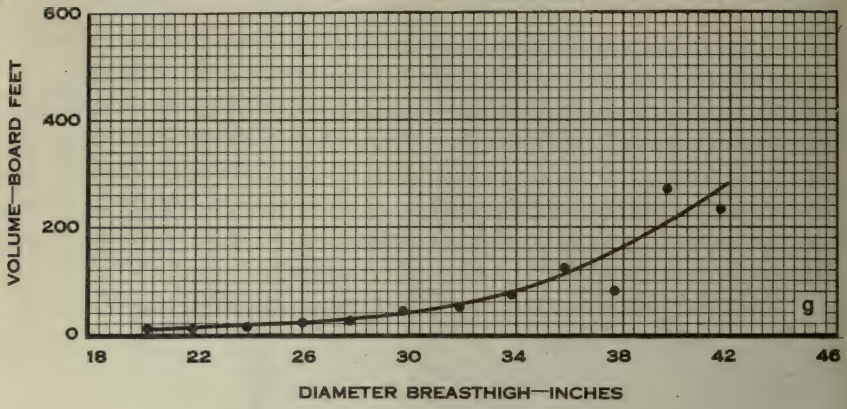


FIG. 28.—Shop 1″.

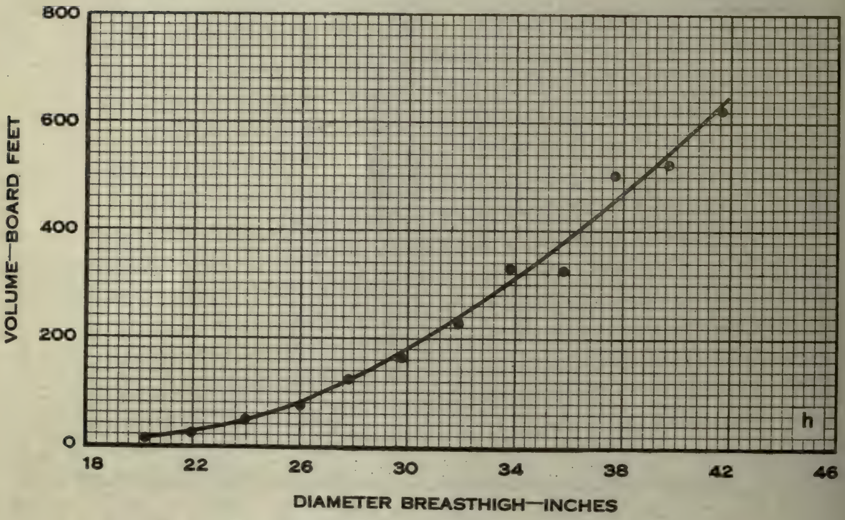


FIG. 29.—No. 2 Shop, 6/4″.

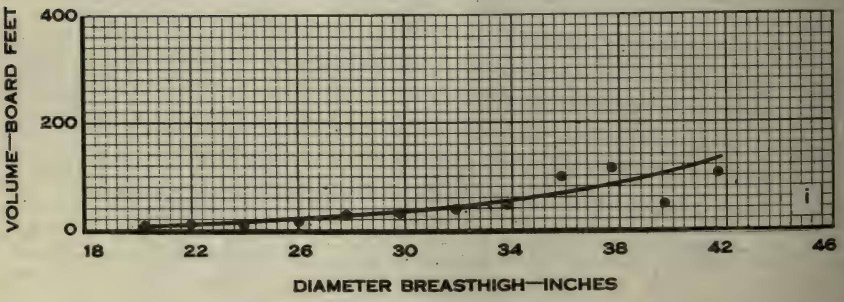


FIG. 30.—Shims.

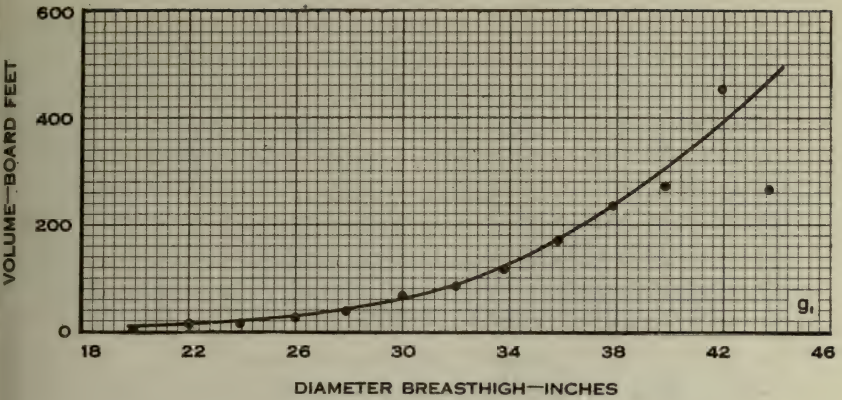


FIG. 31.—Shop 1″.

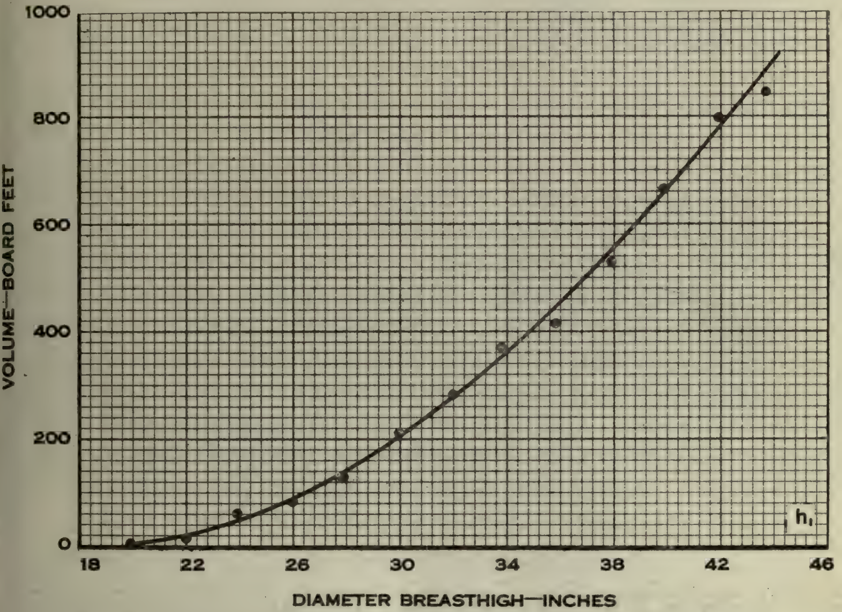


FIG. 32.—No. 2 Shop, 6/4″.

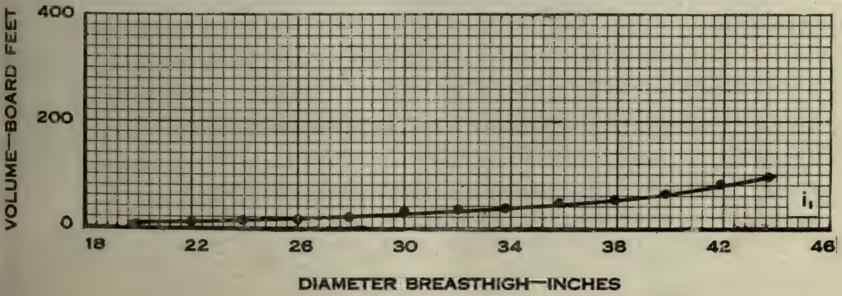


FIG. 33.—Shims.

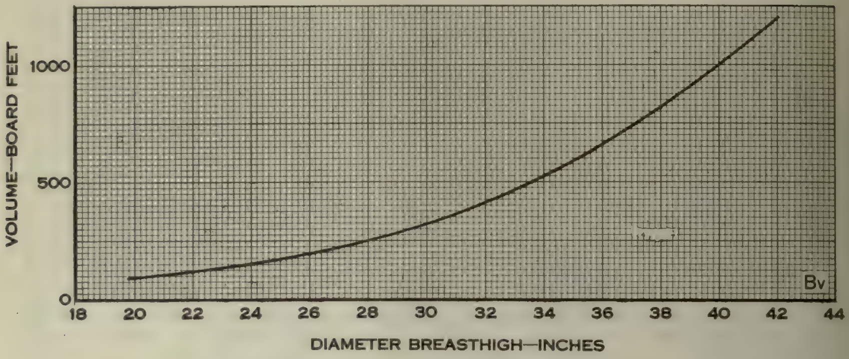


FIG. 34.—Total of intermediate grades sawed from immature trees.

$$e + f + g + h + i = Bv.$$

Low Grades Sawed From Immature Trees.

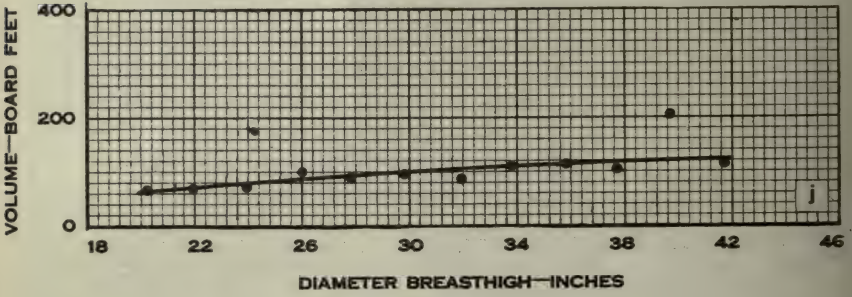


FIG. 35.—Box 1″.

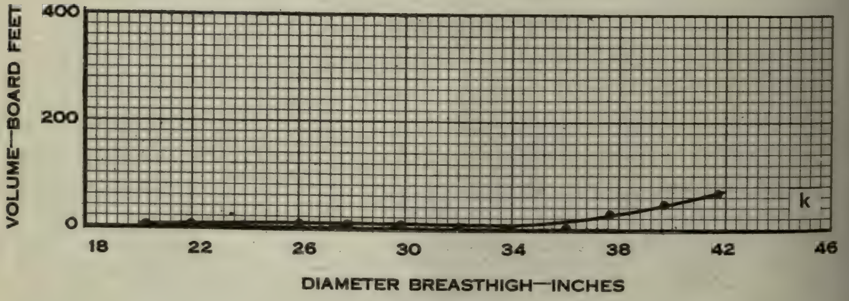


FIG. 36.—Culls.

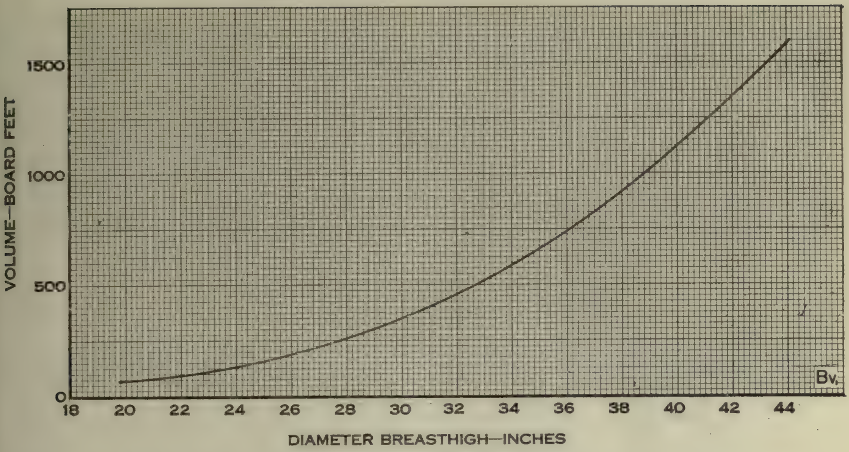


FIG. 37.—Total of intermediate grades sawed from mature trees.

$$e_1 + f_1 + g_1 + h_1 + i_1 = Bv_1.$$

Low Grades Sawed From Mature Trees.

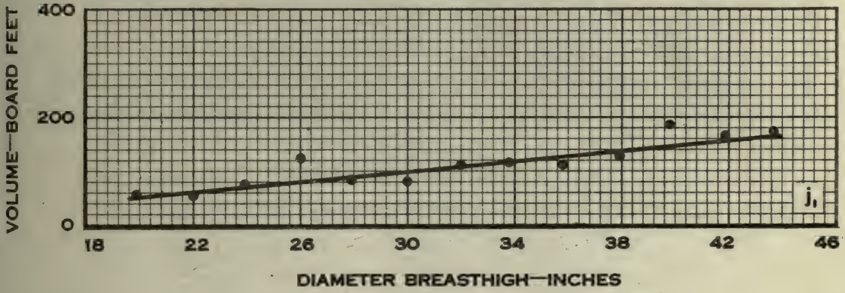


FIG. 38.—Box 1″.

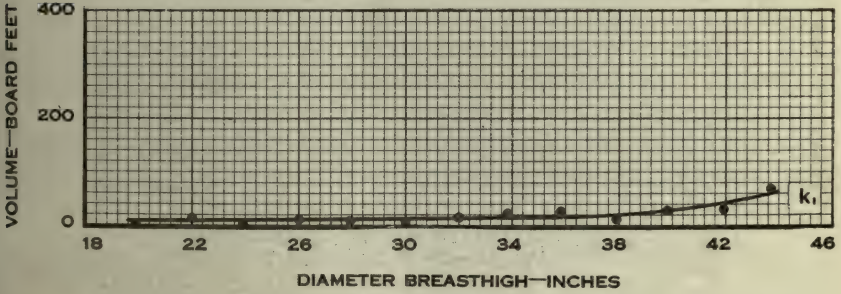


FIG. 39.—Culls.

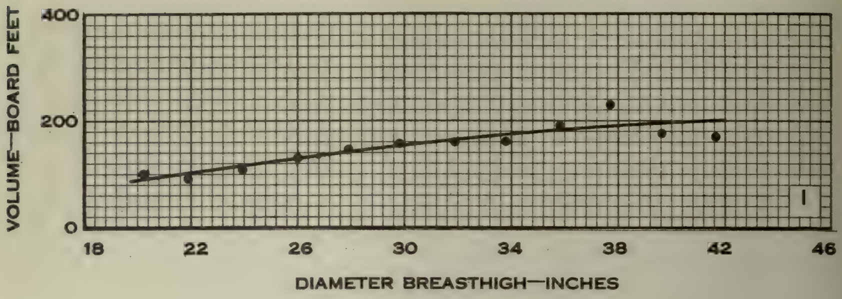


FIG. 40.—Box, 6/4″.

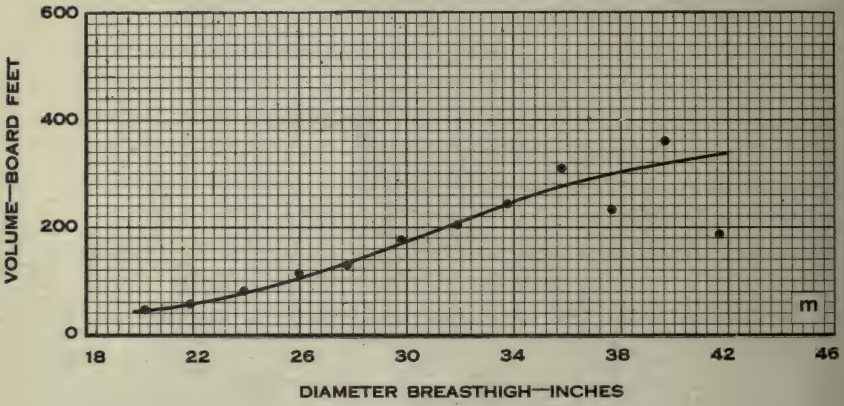


FIG. 41.—No. 3 Shop, 6/4″.

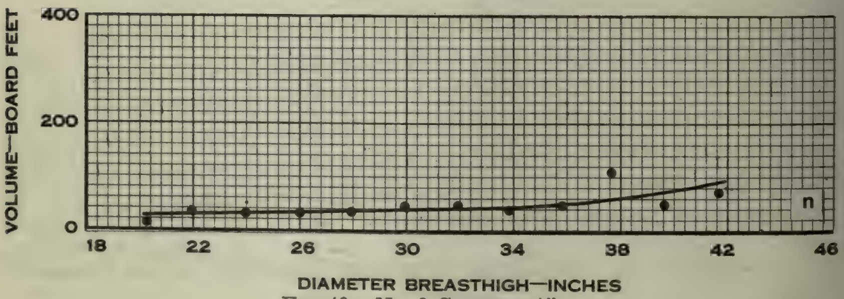


FIG. 42.—No. 3 Common, 1″.

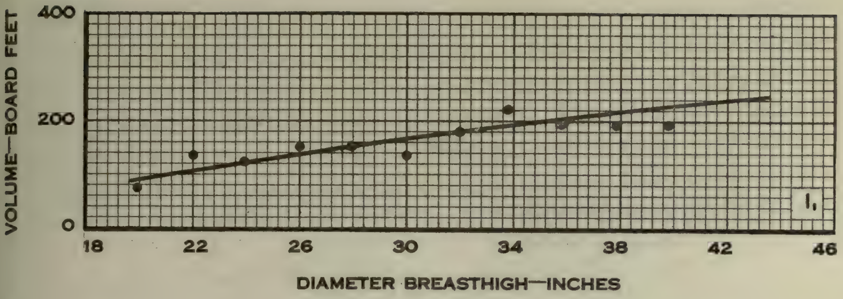


FIG. 43.—Box, 6/4″.

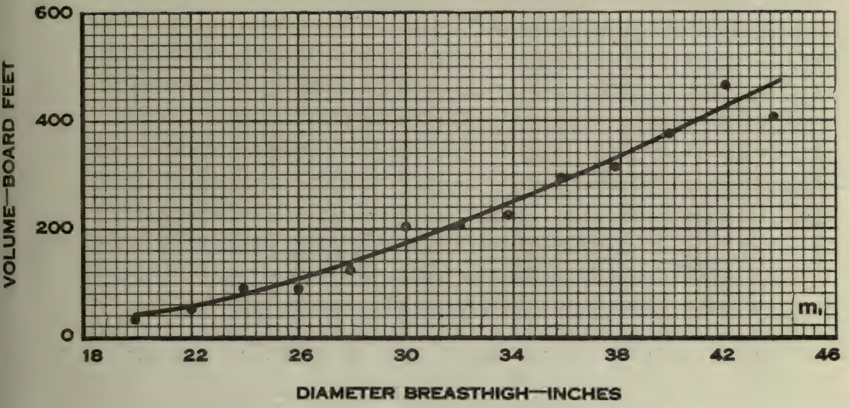


FIG. 44.—No. 3 Shop, 6/4″.

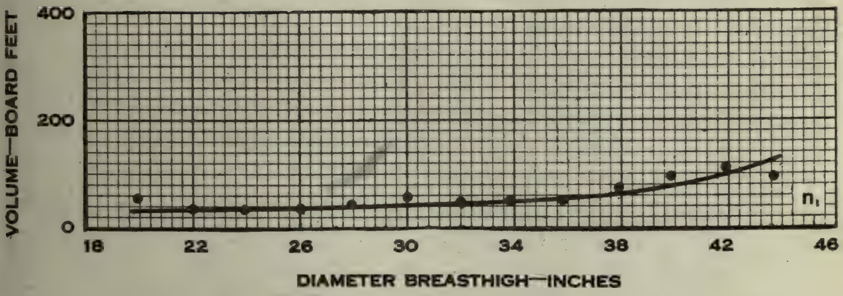


FIG. 45.—No. 3 Common, 1″.

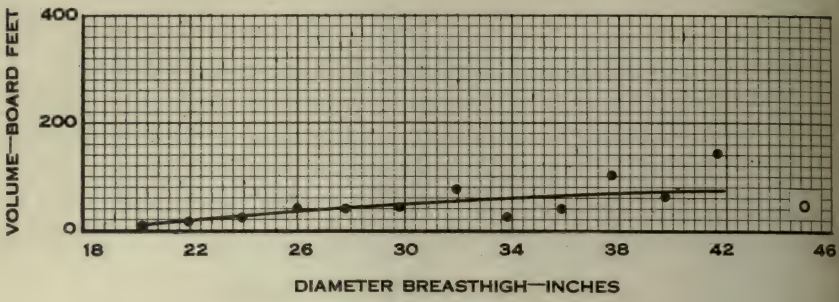


FIG. 46.—Plank, 3″.

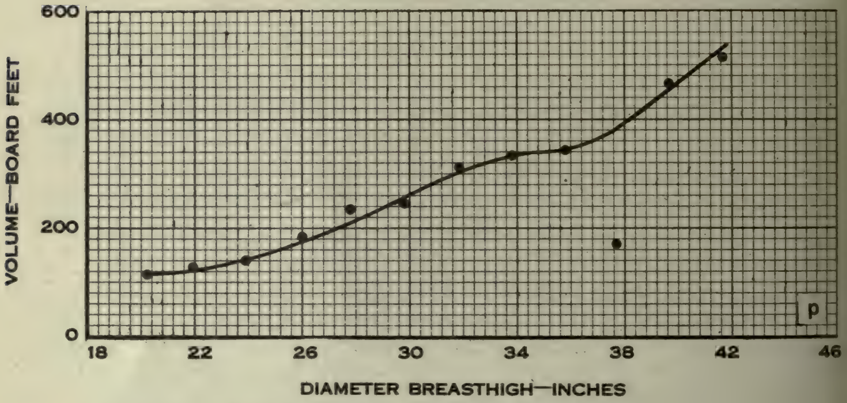


FIG. 47.—4″ x 4″ and Larger.

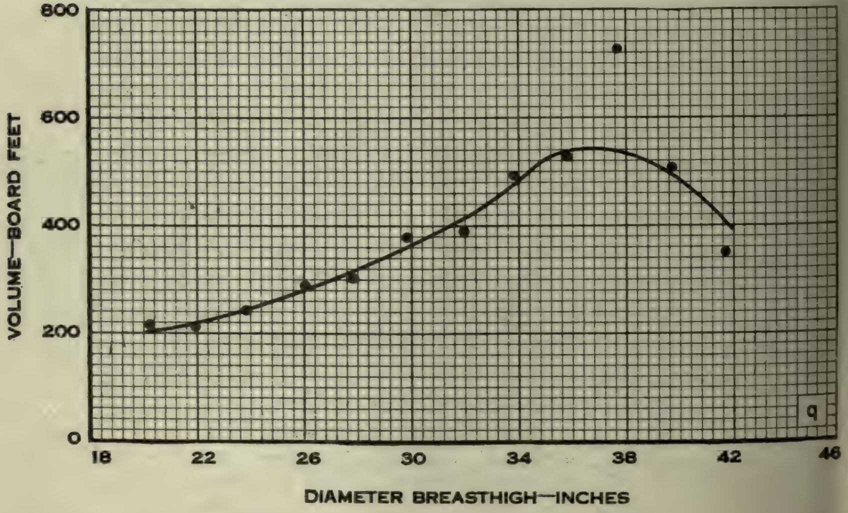


FIG. 48.—2″ x 4″ and Wider, No. 1 Dim.

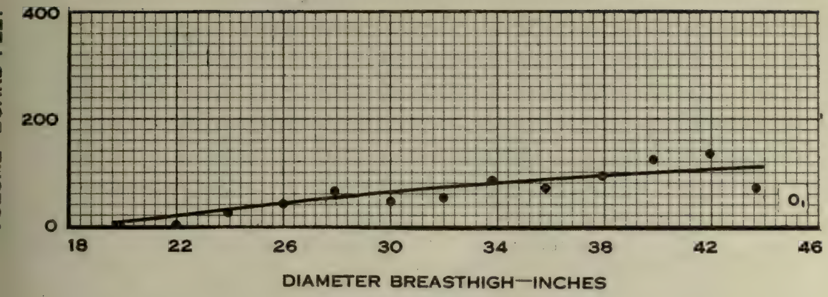


FIG. 49.—Plank, 3″.

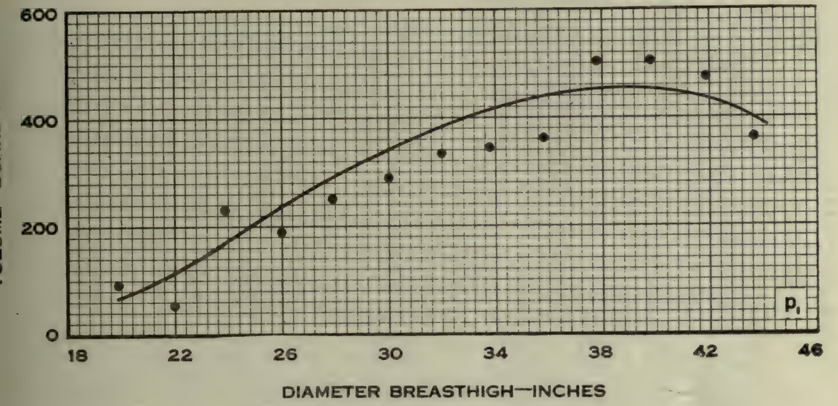


FIG. 50.—4″ x 4″ and Larger.

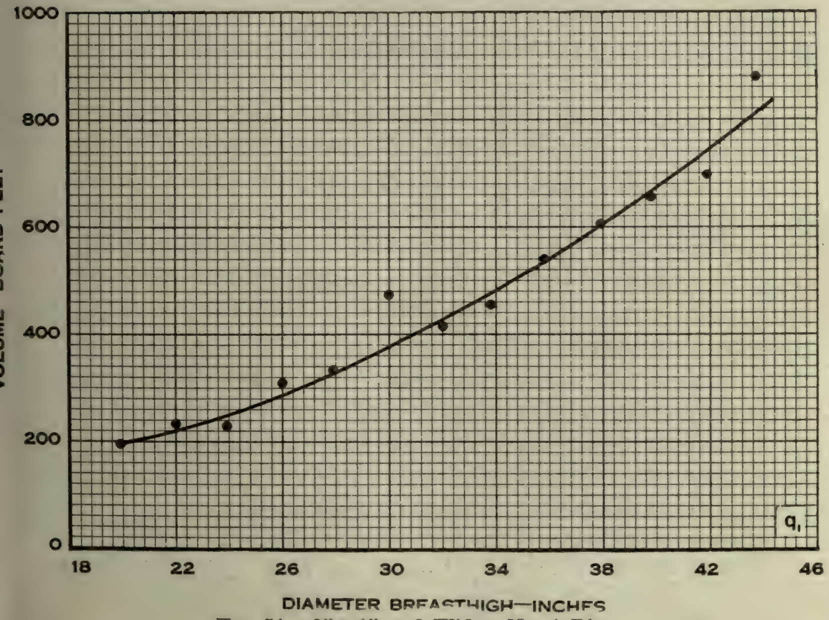


FIG. 51.—2″ x 4″ and Wider, No. 1 Dim.

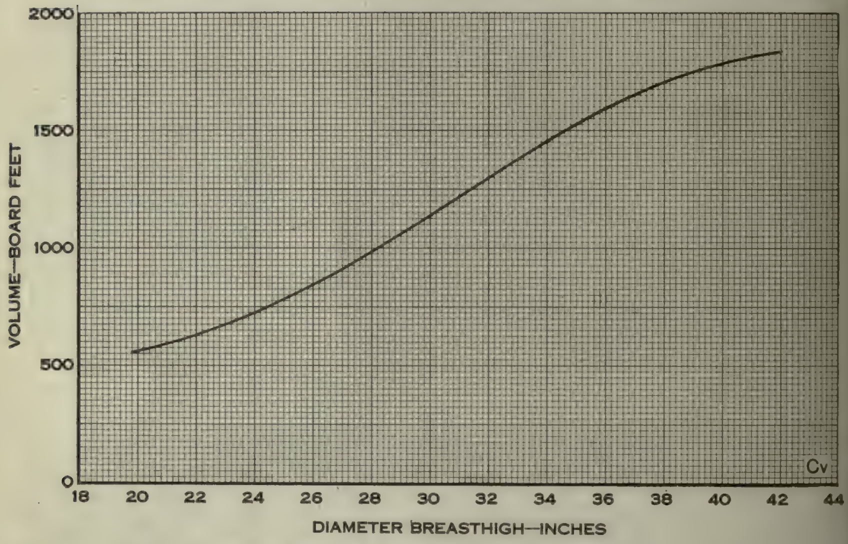


FIG. 52.—Total of low grades sawed from immature trees.

$$j + k + l + m + n + o + p + q = Cv.$$

NOTE.—$Av + Bv + Cv = A =$ Lumber actually sawed out at mill. Curve A is shown in Fig. 11.

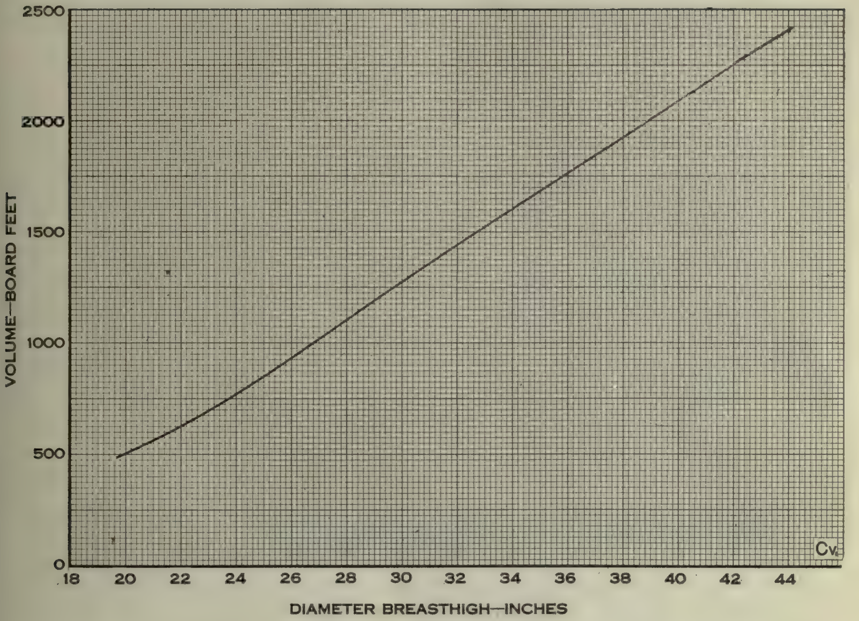


FIG. 53.—Total of low grades sawed from mature trees.

$$j_1 + k_1 + l_1 + m_1 + n_1 + o_1 + p_1 + q_1 = Cv_1.$$

NOTE.—$Av_1 + Bv_1 + Cv_1 = A_1 =$ Lumber actually sawed out at mill. Curve A_1 is shown in Fig. 13.

Grades Sawed From Immature Trees of Different Diameters Breast-high, Expressed in Per Cent of Total Sawed Out.

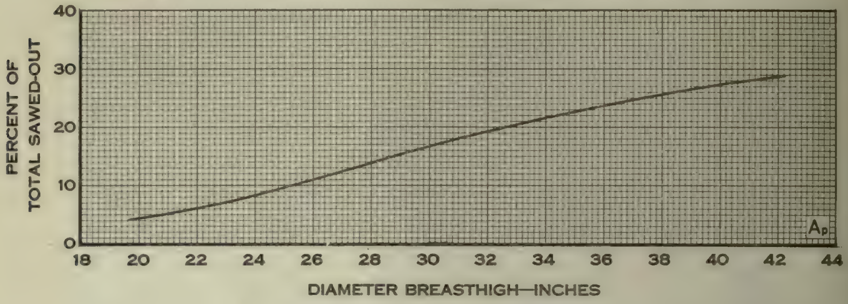


FIG. 54.—High grades. $\frac{100\ Av}{A} = Ap.$

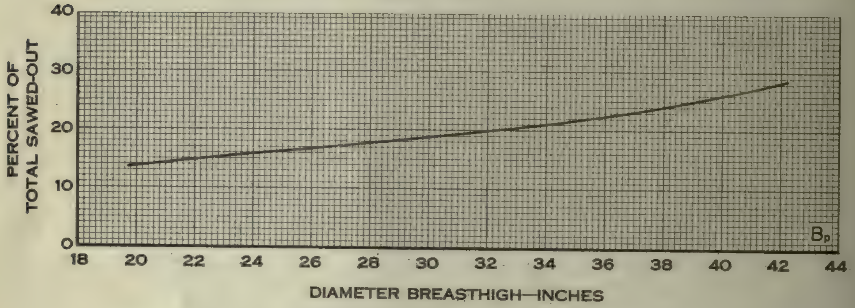


FIG. 55.—Intermediate grades. $\frac{100\ Bv}{A} = Bp.$

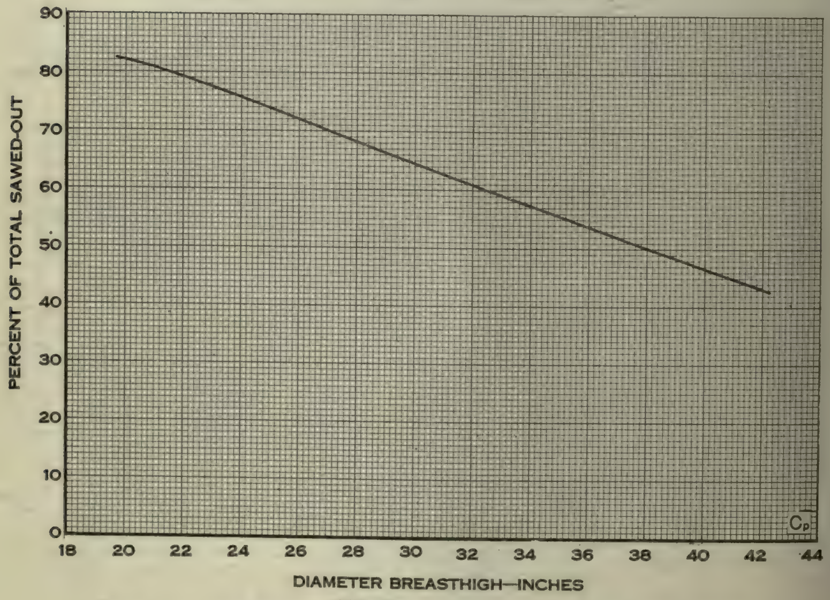


FIG. 56.—Low grades. $\frac{100\ Cv}{A} = Cp.$ $Ap + Bp + Cp = 100\%.$

Grades Sawed From Mature Trees of Different Diameters Breasthigh, Expressed in Per Cent of Total Sawed Out.

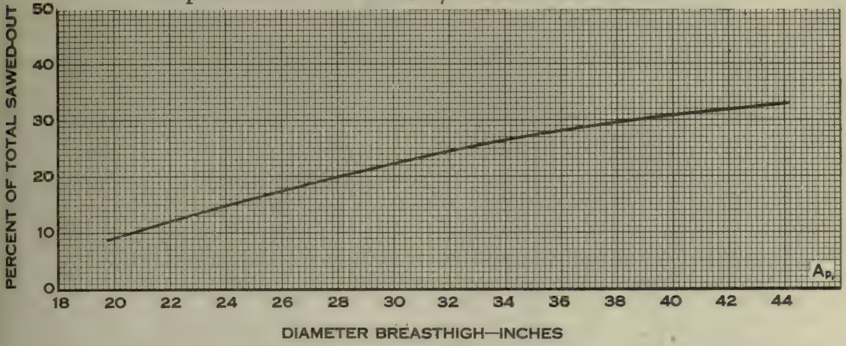


FIG. 57.—High grades. $\frac{100\ Av_1}{A_1} = Ap_1$.

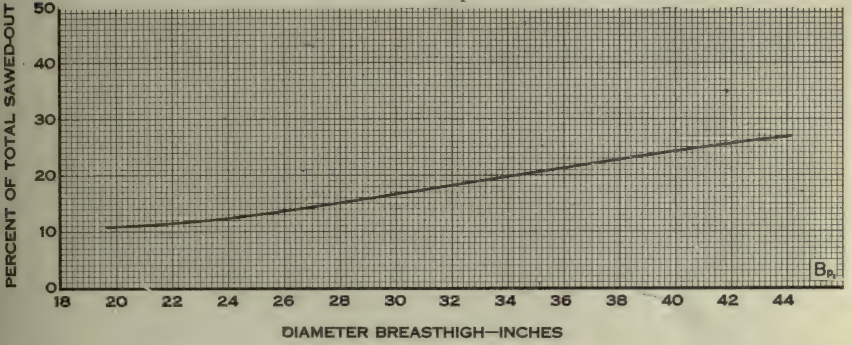
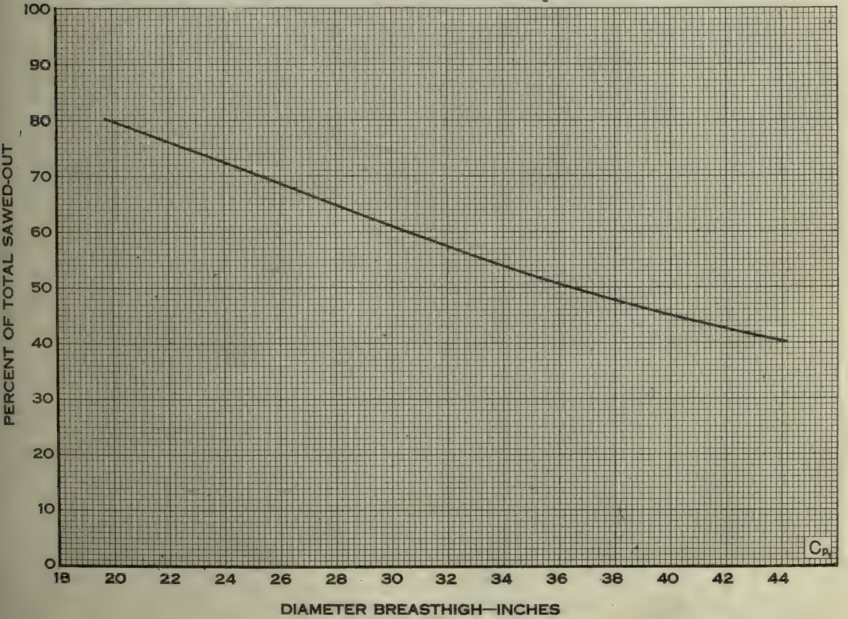


FIG. 58.—Intermediate grades. $\frac{100\ Bv_1}{A_1} = Bp_1$.



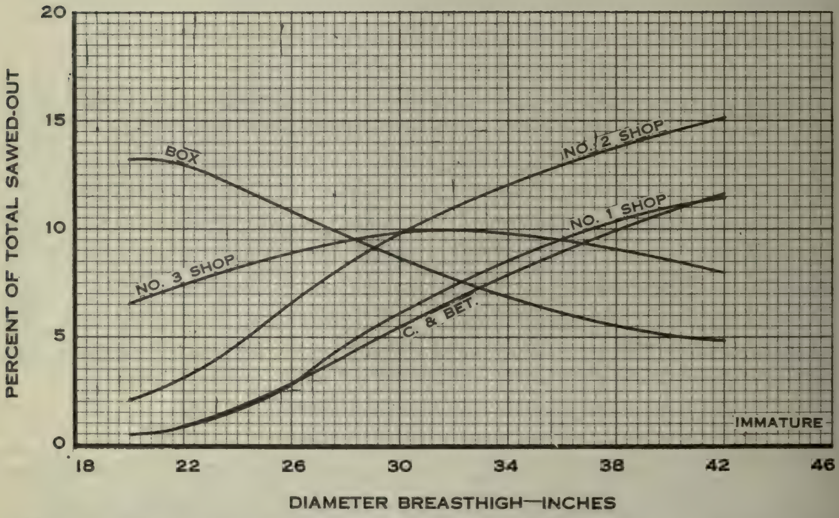


FIG. 60.—A comparison of high, intermediate and low grade curves, which show the total per cent sawed out of each grade from immature trees of different diameters breasthigh. Note the increasing per cent, indicated by the high grades, and the decreasing per cent indicated by the low grades. This is due to quality increment. In no case does the volume in board feet of low grades contained in a tree become smaller, or even hold constant as the tree increases in size; but the fractional part that a certain grade is of the whole merchantable volume may hold constant, decrease or increase, all depending upon the quality of the successive layers of wood formed during growth.

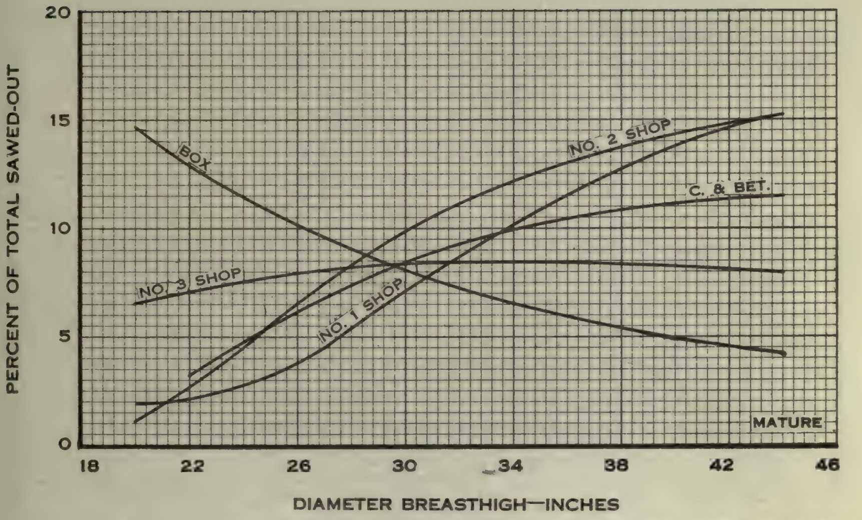


FIG. 61.—A comparison of high, intermediate and low grade curves, which show the total per cent sawed out of each grade from mature trees of different diameters breasthigh. Note the increasing per cent, indicated by the high grades, and the decreasing per cent indicated by the low grades. This is due to quality increment. In no case does the volume in board feet of low grades contained in a tree become smaller, or even hold constant as the tree increases in size; but the fractional part that a certain grade is of the whole merchantable volume may hold constant, decrease or increase, all depending upon the quality of the successive layers of wood formed during growth.

Value.

Value of Grades Sawed From Immature Trees of Different Diameters Breasthigh, Expressed in Dollars and Cents.

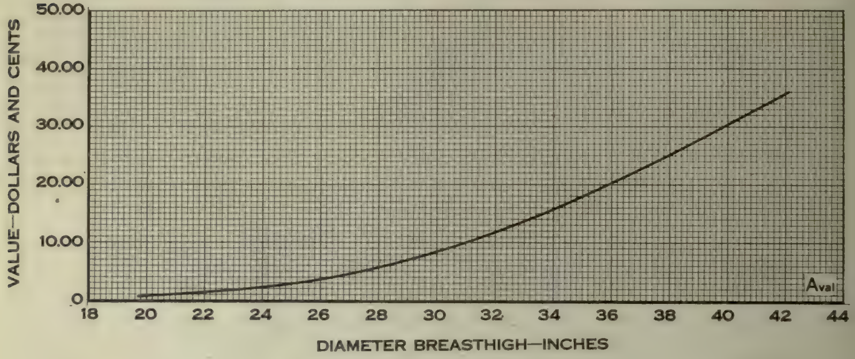


FIG. 62.—High grades.

$$.032a + .030b + .027c + .025d = Aval.$$

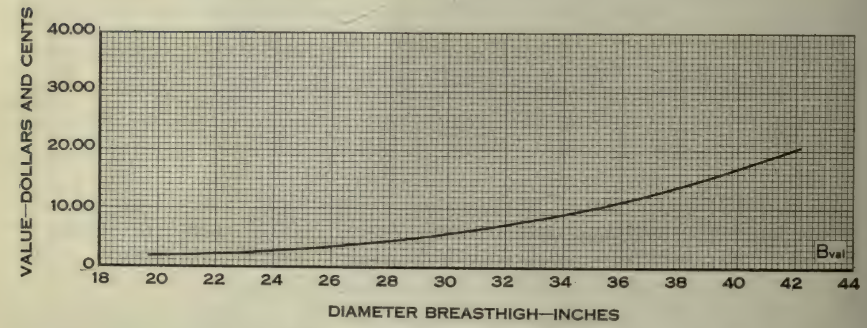


FIG. 63.—Intermediate grades.

$$.022e + .018f + .018g + .018h + .007i = Bval.$$

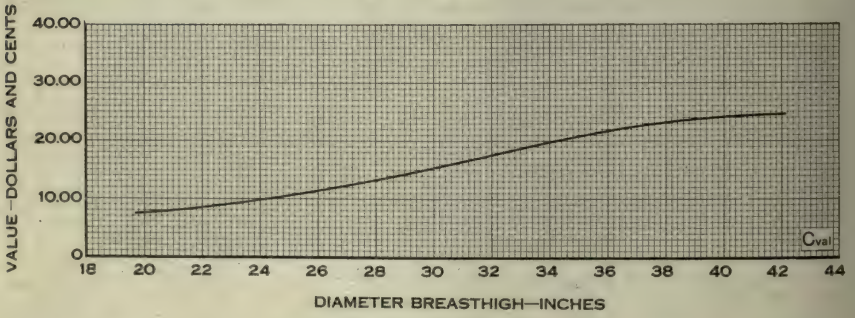


FIG. 64.—Low grades.

$$.009j + .007k + \text{-------}\ .015q = Cval.$$
$$Aval + Bval + Cval = B = \text{Value per tree.}$$

Value of Grades Sawed From Mature Trees of Different Diameters Breasthigh, Expressed in Dollars and Cents.

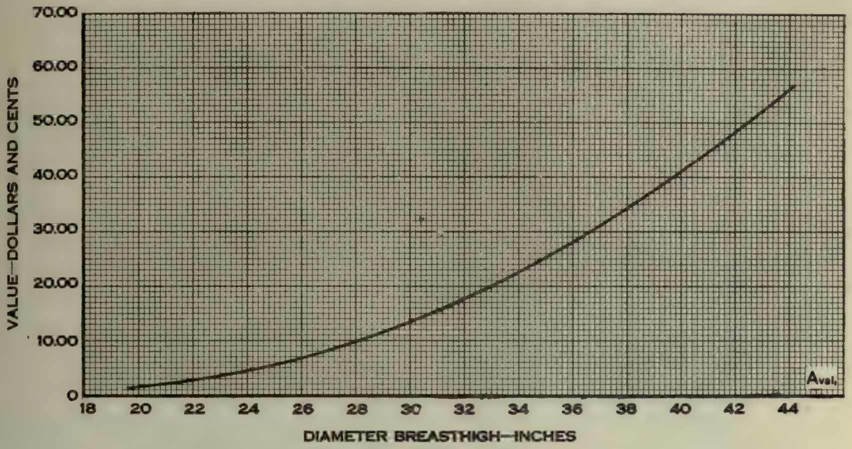


FIG. 65.—High grades.

$$.032a_1 + .030b_1 + .027c_1 + .025d_1 = Aval_1.$$

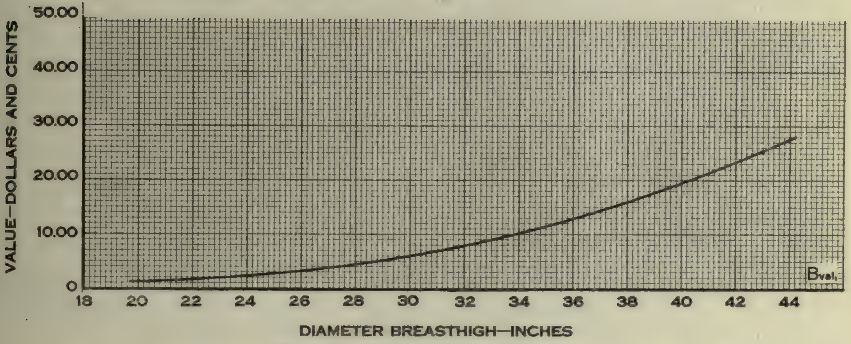


FIG. 66.—Intermediate grades.

$$.022e_1 + .018f_1 + .018g_1 + .018h_1 + .007i_1 = Bval_1.$$

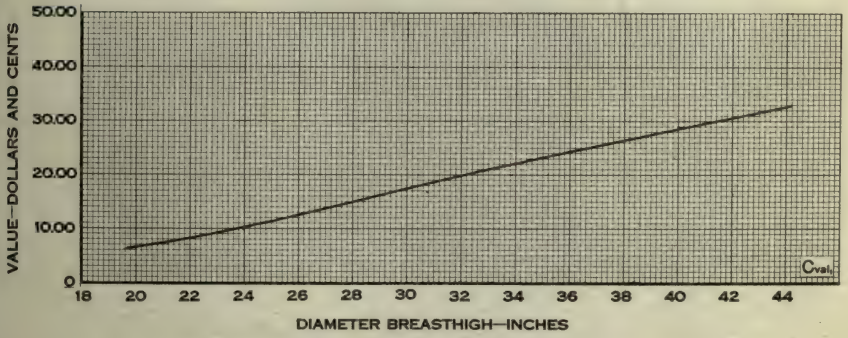


FIG. 67.—Low grades.

$$.009j_1 + .007k_1 + \text{--------} .015q_1 = Cval_1.$$
$$Aval_1 + Bval_1 + Cval_1 = B_1 = \text{Value per tree.}$$

Curves Showing Average Value per Tree and per 1,000 Board Feet for Immature Western Yellow Pine.

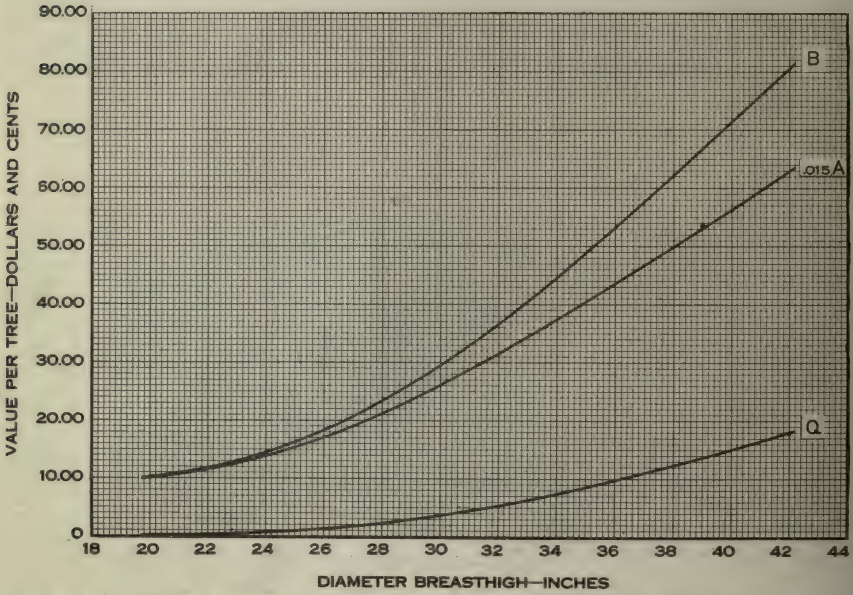


FIG. 68.—Curve B shows the average value, in dollars and cents, of immature trees of different diameters breasthigh. $B = Aval + Bval + Cval$. Curve .015A shows the increase in value due to quantity increment. Curve Q shows the increase in value due to quality increment.

$$.015A + Q = B.$$

Curves Showing Average Value per Tree and per 1,000 Board Feet for Mature Western Yellow Pine.

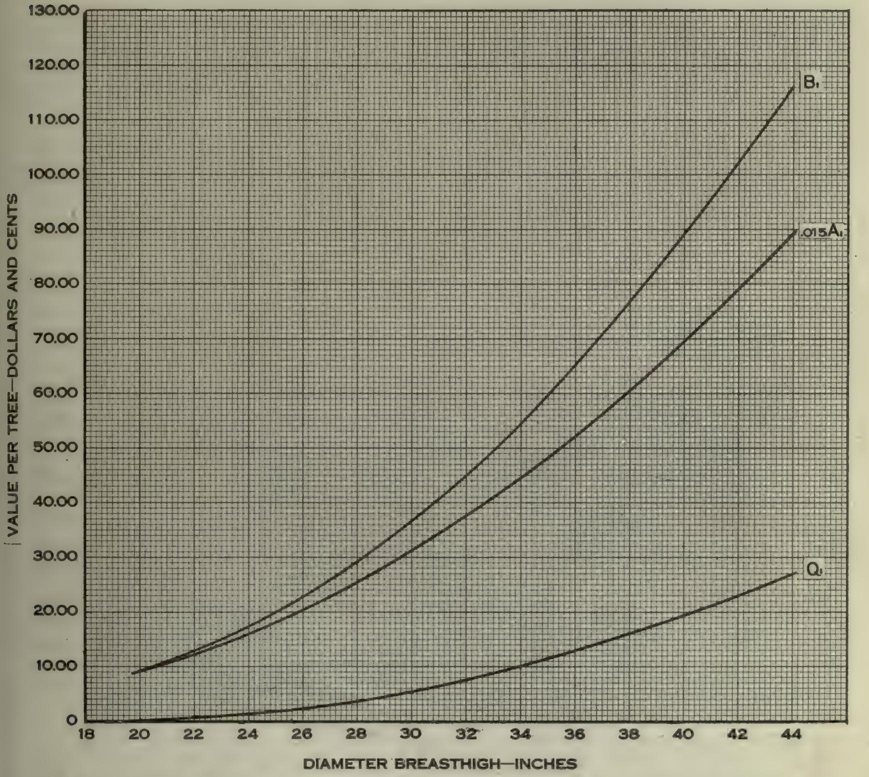


FIG. 69.—Curve B_1 shows the average value, in dollars and cents, of mature trees of different diameters breasthigh. $B_1 = Aval_1 + Bval_1 + Cval_1$. Curve $.015A_1$ shows the increase in value due to quantity increment. Curve Q_1 shows the increase in value due to quality increment.

$$.015A_1 + Q_1 = B_1.$$

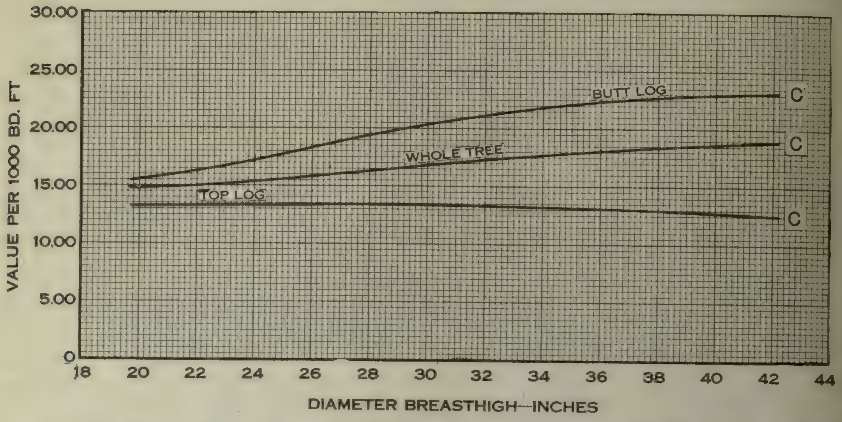


FIG. 70.—Curves showing the value in dollars and cents per thousand board feet of lumber sawed from butt logs, whole trees, and top logs, of immature trees of different diameters breasthigh.

$$\frac{1000\ B}{A} = C = \text{Value per 1000 B.M.}$$

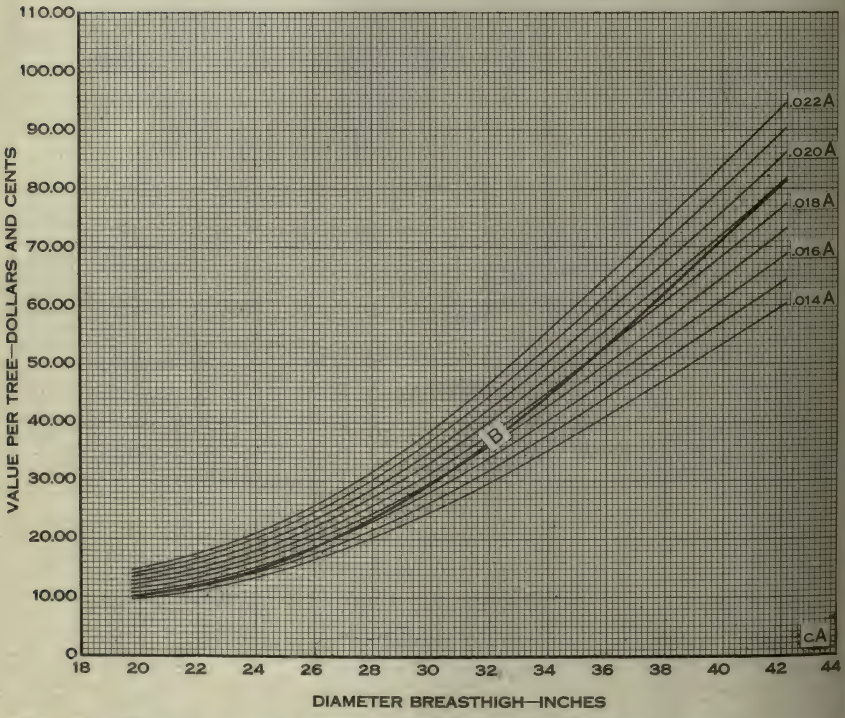


FIG. 71.—Curve B, showing average values in dollars and cents of immature trees of different diameters breasthigh, contoured for quality. (This illustrates to what extent the quality increment affects the value per tree. Both value per tree and per 1000 board feet can be read from this curve.)

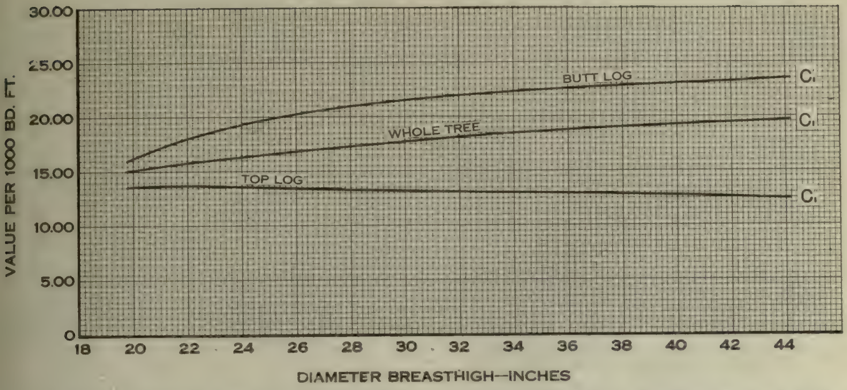


FIG. 72.—Curves showing the value in dollars and cents per thousand board feet of lumber sawed from butt logs, whole trees and top logs, of mature trees of different diameters breasthigh.

$$\frac{1000\ B_1}{A_1} = C_1 = \text{Value per 1000 B.M.}$$

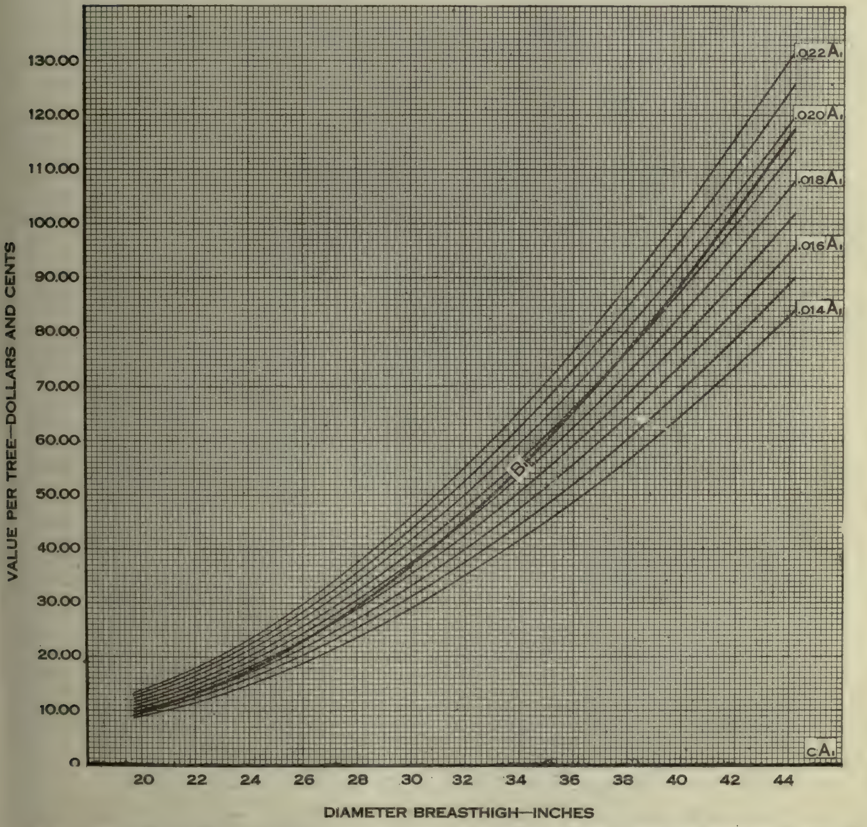


FIG. 73.—Curve B_1, showing average values in dollars and cents of mature trees of different diameters breasthigh, contoured for quality. (This illustrates to what extent the quality increment affects the value per tree. Both value per tree and per 1000

Volume Contoured for Height.

Contoured curves showing average volume in board feet, also in cubic feet, contained in merchantable portion of immature trees, of different merchantable lengths, and diameters breasthigh.

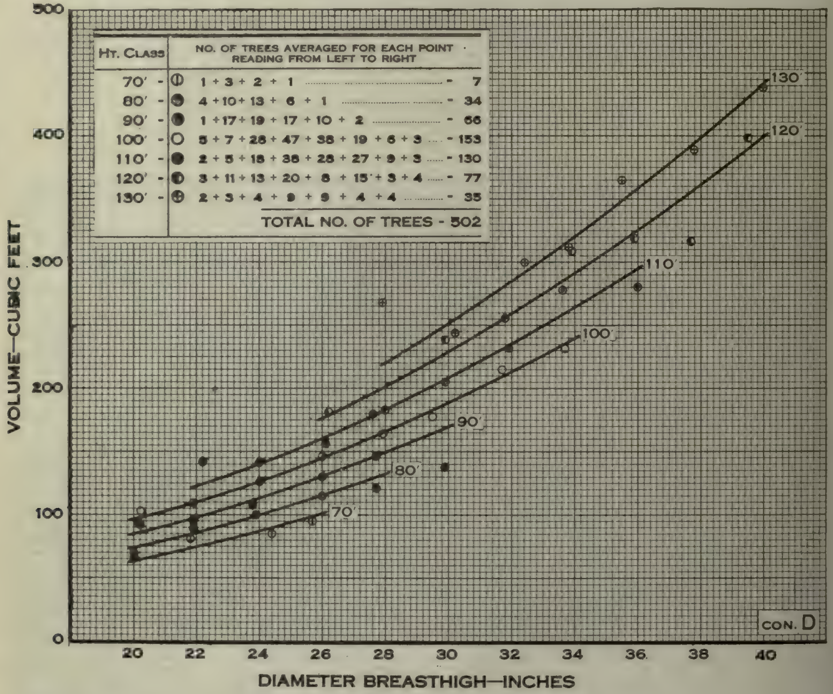


FIG. 74.—Total volume in cubic feet inside bark from the stump to a height where the tree is 6″ in diameter outside the bark.

Contoured curves showing average volume in board feet, also in cubic feet, contained in merchantable portion of mature trees, of different merchantable lengths, and diameters breasthigh.

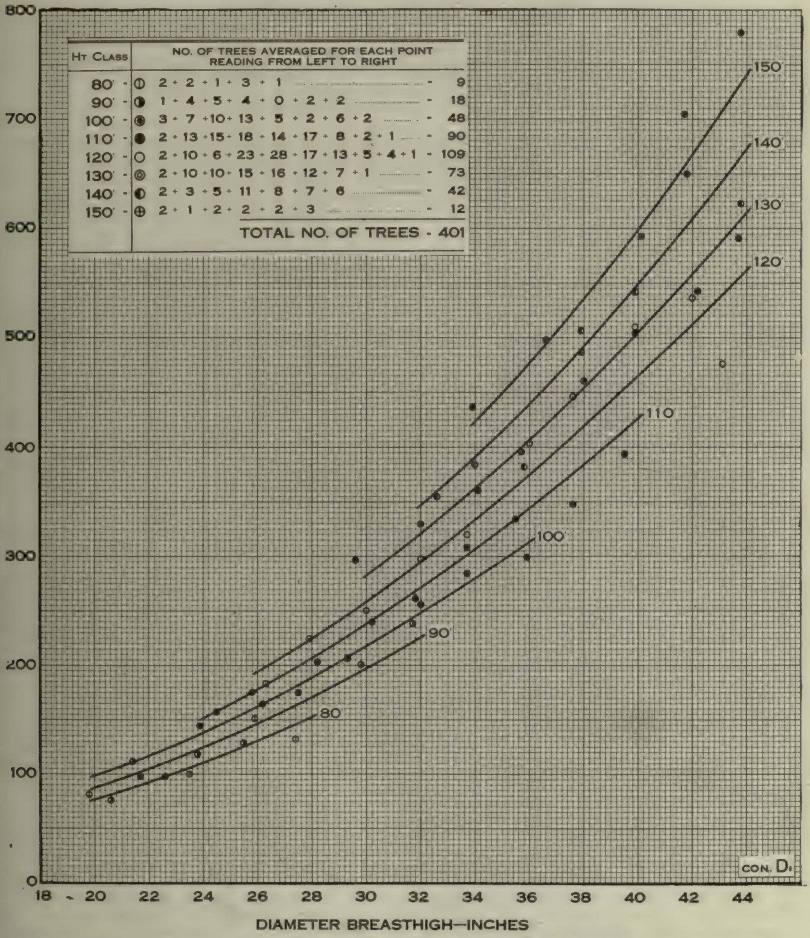


FIG. 75.—Total volume in cubic feet inside bark from the stump to a height where the tree is 6″ in diameter outside the bark.

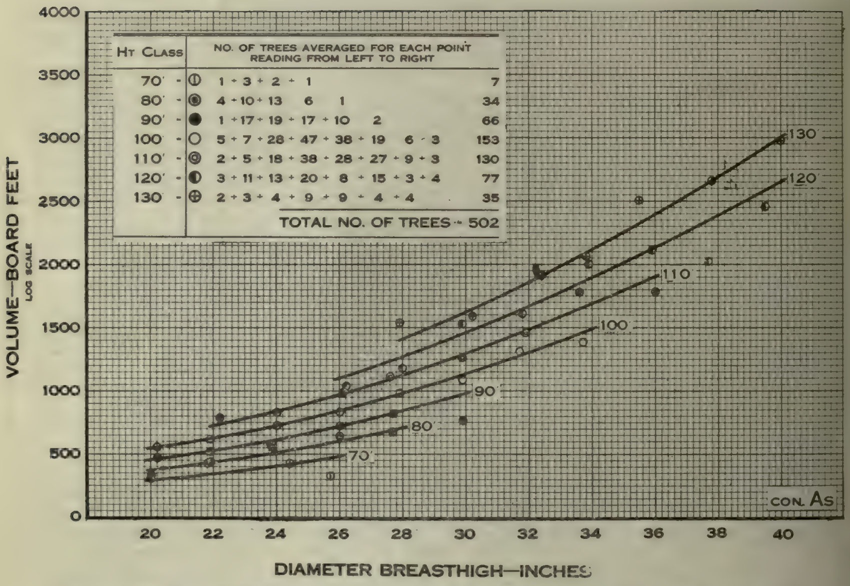


FIG. 76.—Total volume in board feet as shown by the Spaulding Log Rule.

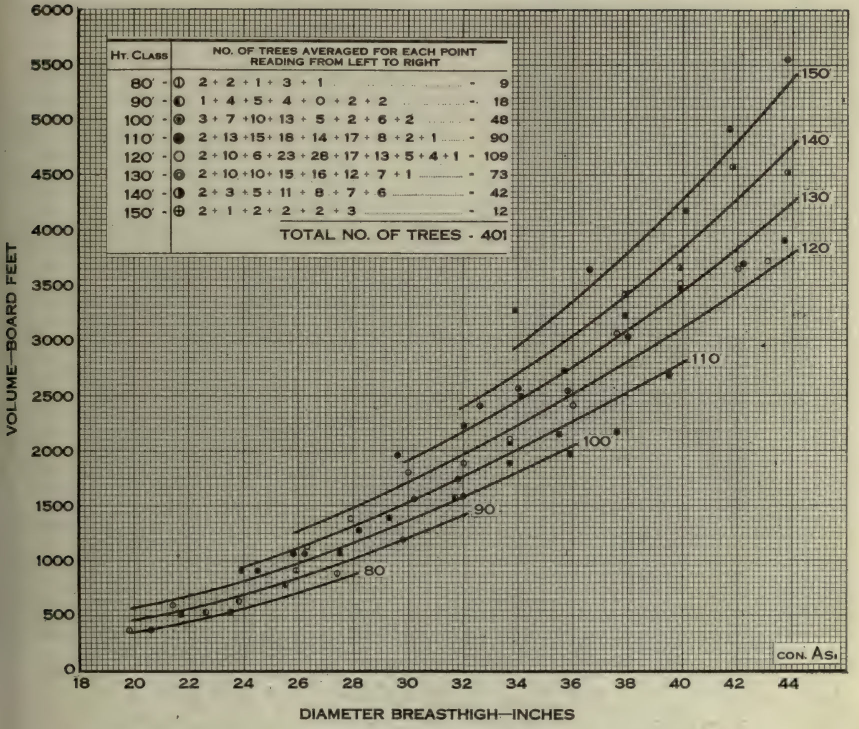


FIG. 77.—Total volume in board feet as shown by the Spaulding Log Rule.

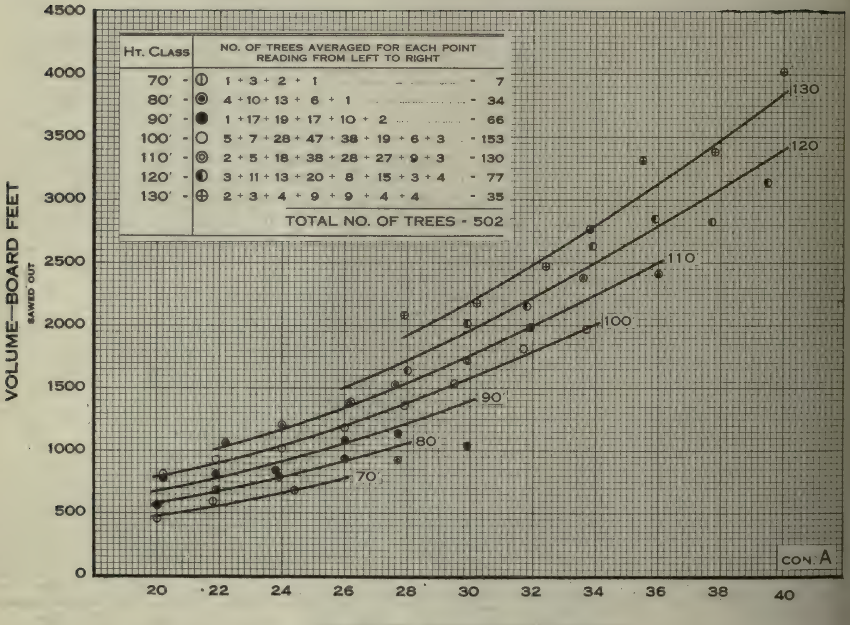


FIG. 78.—Total volume in board feet actually "sawed out" at mill.

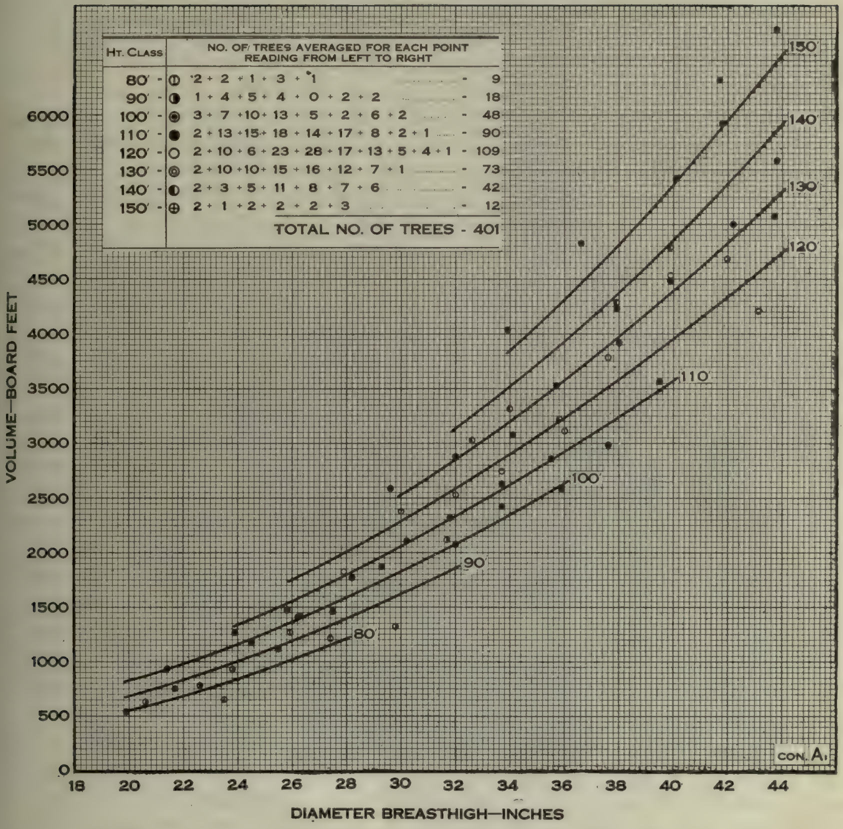


FIG. 79.—Total volume in board feet actually "sawed out" at mill.

Growth.

The growth determinations shown in the following diagrams are based on measurements of the average radii of stumps of felled trees of known dimensions. The average rate of growth of each individual tree, as shown by the last fifty annual rings formed, or last fifty years of the life of each tree, was determined. These rates were then corrected so as to read at diameter breasthigh by means of reducing factors, as shown in Figs. 81 and 82. Trees were then grouped in diameter classes, and those of each diameter class were arranged according to rate of growth, from the minimum to the maximum. The number of trees forming each class is the sample of that class, and an individual tree therefore may represent a large percentage of the sample or a small one, all depending upon the total number of trees included in the class.

The larger the number of trees composing a sample the more authentic are the final results, since the variability from the true minimum to the true maximum can thus be more closely obtained. In any sample on rate of growth it would be absurd to assume that the minimum indicated applied to the slowest growing tree in the timber region being studied, or that the maximum of the sample was the fastest growing tree. After determinations on about seventy-five or one hundred trees have been made for a diameter class, the value of the sample is increased very slowly by the addition of more trees; since the principal effect of additional trees will be to lower the minimum and raise the maximum, while the body of the sample will be practically unaffected.

In Figs. 83 and 84 samples for the various diameter classes are compared. These samples are not composed of the same number of trees; had they been, the final results would have been very little different from these here given. In fact, the number of trees comprising each diameter class shown in Figs. 83 and 84 is a better sample than though the number in each case were the same, since these numbers are to a large degree representative of the quantity of trees of each diameter class to be expected from a given tract similar to the one under consideration.

Curves shown in Figs. 85 and 86 are plotted directly from Figs. 83 and 84, and show the rate of growth per decade at diameter breasthigh of trees of different sizes. Curves 87 and 89 were obtained by plotting the increments of total sawed out volume in board feet as indicated by the diameter growth. Figs. 88 and 90 were obtained by expressing curves in Figs. 87 and 89 in per cent of total sawed out.

Curves shown in Figs. 91 and 93 were obtained by plotting increments of total value per tree, as indicated by the diameter growth for the average, and then for the highest and lowest ten per cent, while Figs. 92 and 94 show the same results expressed as a per cent of the total value per tree.

The relation of growth to grades or quality.

Wood formed by the growth of western yellow pine trees after they have reached maturity is very fine grained, free from knots in the lower part and uniform in texture. No new limbs are formed after maturity, as evidenced by the absence of small live branches. All living branches are large, and usually high up in the tree. Therefore, no new knots are formed, and the tendency of the tree is to cover up by the newly formed wood of each season's growth the knots formed in early life by the growth of small limbs which eventually die and drop off.

Retardation in growth continues in mature trees until the rate of growth in radius measured on the stump becomes less than one-tenth of an inch in a period of ten years. Such a low rate is hardly sufficient to sustain life, and it is safe to say that the deterioration in such trees will more than offset increase in value due to growth.

Lumber of all grades usually can be sawed from a fair sized mature tree. In the butt log will be found high grade, clear material, and in large logs several boards of clear lumber may be sawed without changing the position of the log before defects in the form of knots are reached. These knots found in the center of all butt logs are usually small and numerous, since they are the remaining evidence of limbs formed in the early life of the tree. They become smaller and more numerous as the center of the log is approached. The mark of every limb that the tree ever had at heights not exceeding the point where the butt log was sawed are in evidence, and always have held the same position in the tree that they originally held—always the same distance from the ground, etc. The butt log contains wood formed at all stages of the tree's life. The quality ranges from clear, straight, fine-grained material found in the layers near the bark to coarse-grained lumber found below this, and, finally, to fine-grained lumber containing numerous pin knots found in the center.

The second log up from the stump contains none of the wood formed while the tree's height was less than the length of the butt log plus the height of the stump. The quality is about the same as found in the butt log, with the exception that the clear material near the bark is not quite as thick, and the knots in the center of the log are larger. This is due to the fact that the tree was larger and older when the wood in the center of the second log was formed, and therefore maintained a crown composed of larger limbs than it did when forming the wood composing the center of the butt log.

The third log from the stump contains none of the wood formed while the tree's height was less than the length of the butt log plus the length of the second plus the height of the stump. Stubs of the old limbs which once formed the crown may be seen still penetrating through the bark. Some of them may be between three and four inches in diameter, and in cases where the tree grew in the open they may be still alive and five or six inches in diameter. The quality of lumber to be expected from this part of the tree may range from Number 1 Shop found near the bark to Number 3 Shop, Number 3 Common and Box found in the center.

In all cases the knots will be much larger in the third log than in the second, and larger in the second than in the butt log. The fourth log up from the stump will contain none of the wood found while the tree's height was less than the distance from the ground to the position occupied in the tree by the large end of this log. Usually a great many stubs of dead limbs are present and there may be quite a few live branches. Only in exceptional cases will it be possible to saw clear material from this part of the tree. The first cut generally yields

Number 2 Shop, and in some cases Number 1 Shop. The knots are larger and farther apart than in any of the logs located farther down, and it is this type of material that can be graded as Shop lumber, since boards free from small knots and containing large ones will usually pass the qualifications of these grades. The center of the log will produce lumber containing many knots of various sizes, and the quality will compare favorably with that of the center of logs nearer the stump. The strength will probably be greater, since the wood was formed after the tree had a good start in life. The grain will be coarser than will be found in the center of the lower logs, but the wood in general will not be as brittle. Timbers cut from this part of the tree will manifest more strength, if the knots are sound, than ones cut from the butt and second logs, which contain wood at the center apt to be brittle, due to the fact that it was laid on before the tree had become vigorous.

All logs above the fourth from the stump will contain large knots extending through the bark in the form of snags and live limbs. The largest knots are generally ones formed by the presence of living branches. The center of these logs will usually grade as Number 3 Shop, Number 3 Common, and Box. The last log in a mature tree has an enormous taper, and the knots are very large. They produce a low grade of lumber, such as Box and Number 3 Common.

The quality of material once formed in a tree, with the exception of the gradual change from sap-wood to heart-wood, remains unchanged by the process of growth. The new layers of wood formed from year to year increase the quality of the tree as a whole, and small and intermediate sized knots are covered by successive layers until clear, straight grained lumber results in the lower portion of the bole near the barked surface in sufficient quantities to be manufactured into boards of various dimensions.

A tree contains all wood formed by the process of growth from its beginning up to the time it is milled, and each layer is unaffected by the formation and accumulation of other layers which follow. The same knots are present in the same location in the tree, and the grain of the wood once formed remains unchanged.

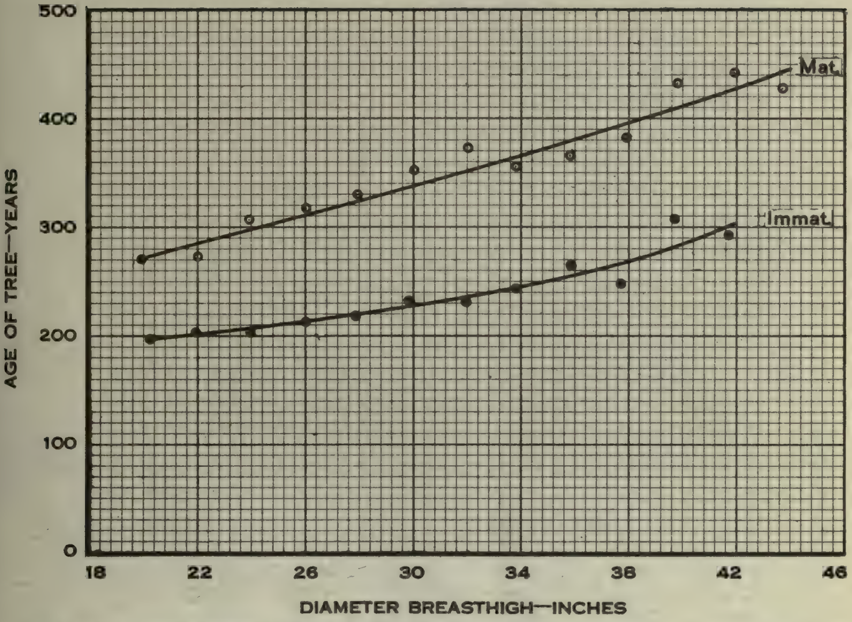


FIG. 80.—Curves showing average age in years of immature and mature western yellow pine trees of different diameters breasthigh.

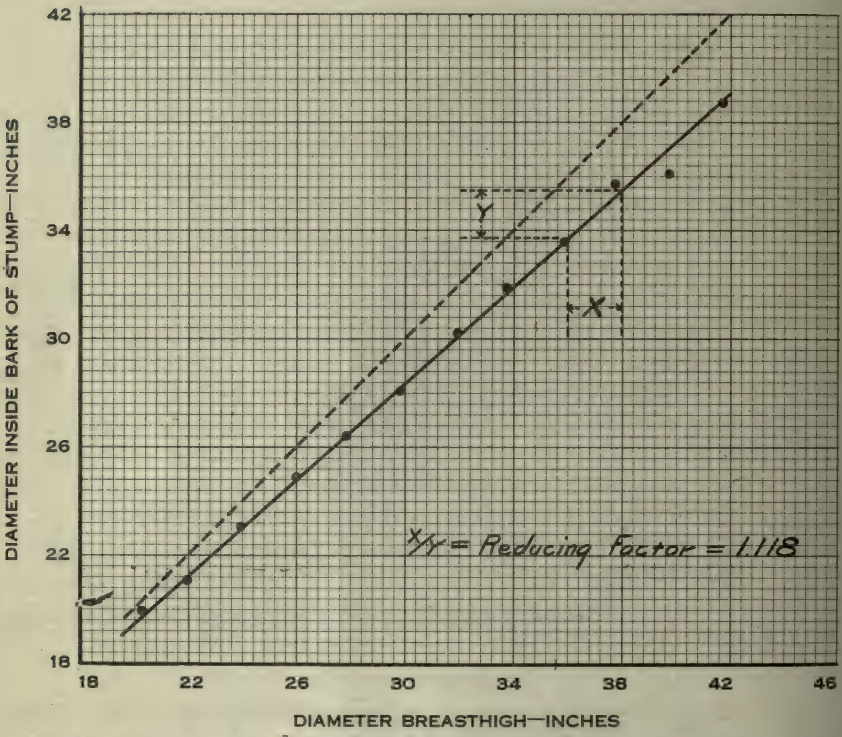


FIG. 81.—Curve showing the relation between diameter inside bark of stump and diameter breasthigh of immature trees. X/Y = reducing factor = 1.118. This factor is used to reduce growth measurements made on the stump to read at diameter breasthigh.

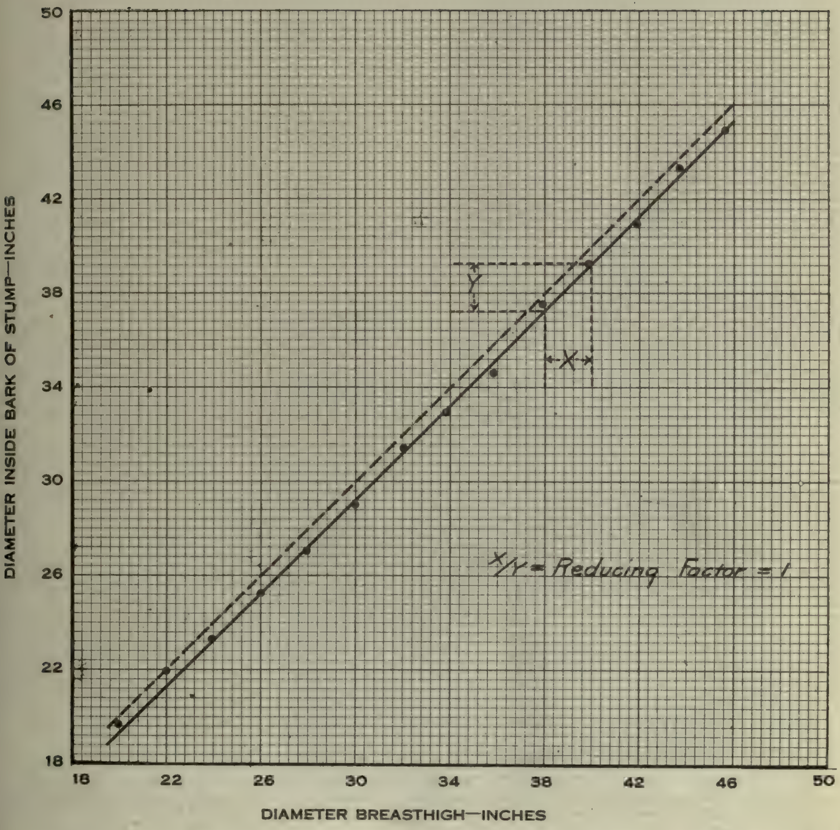


FIG. 82.—Curve showing the relation between diameter inside bark of stump and diameter breasthigh of mature trees. $X/Y = $ reducing factor $= 1.000$. This factor is used to reduce growth measurements made on the stump to read at diameter breasthigh.

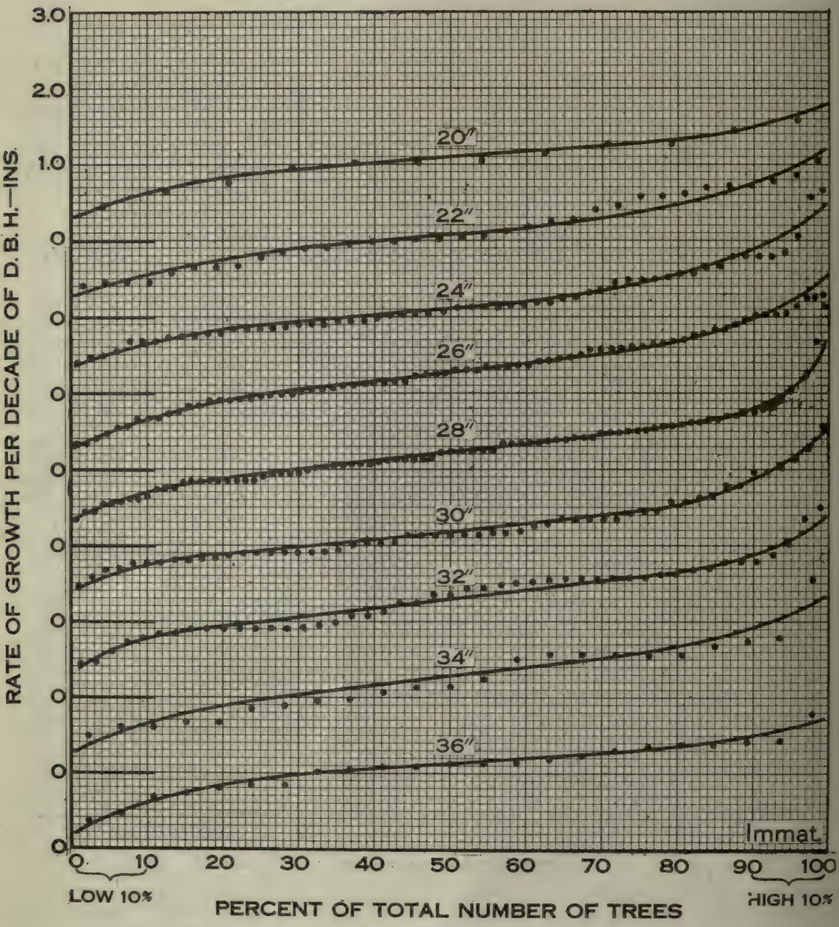


FIG. 83.—Curves showing the rate of growth per decade of diameter breasthigh of immature trees. The top curve marked 20″ is based upon as many trees as there are points on the curve (12), and is constructed by arranging these trees in order of rate of growth from the minimum to the maximum, and plotting rates of growth per decade for ordinates and per cent of the total number of trees, which constitutes the sample, for abscissa. The other curves shown in this figure were constructed in like manner.

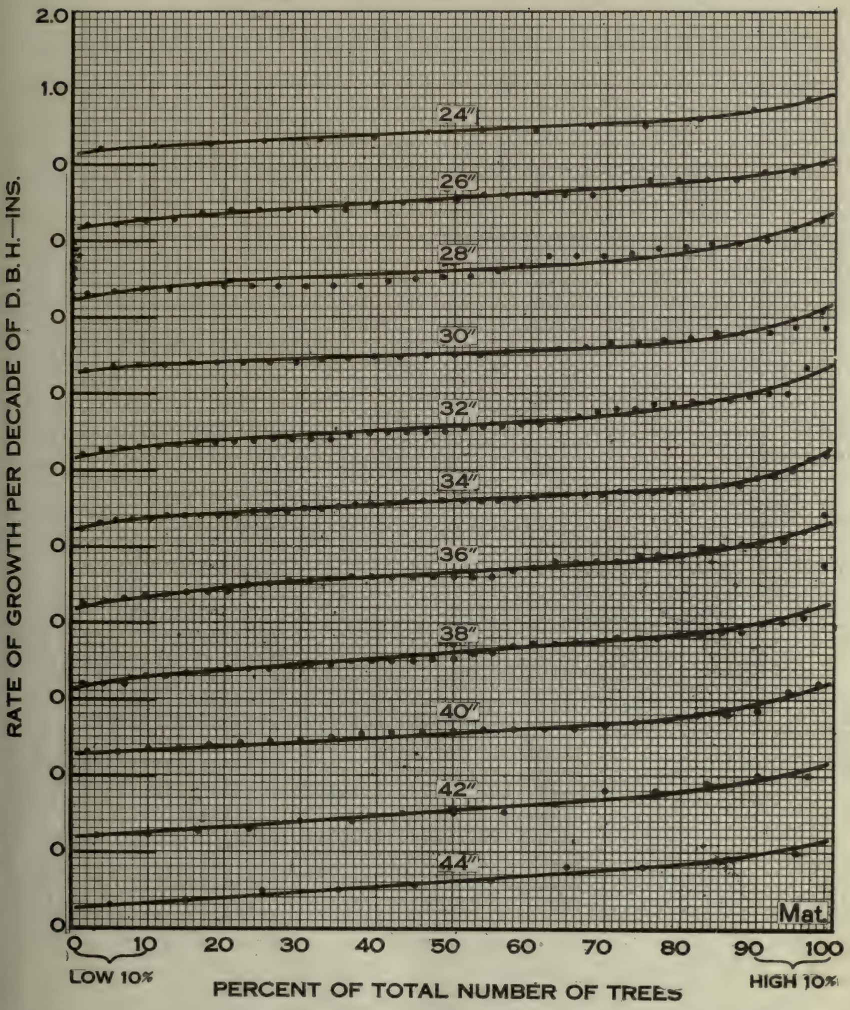


FIG. 84.—Curves showing the rate of growth per decade of diameter breasthigh of mature trees. The top curve marked 20″ is based upon as many trees as there are points on the curve (14), and is constructed by arranging these trees in order of rate of growth from the minimum to the maximum, and plotting rates of growth per decade for ordinates and per cent of the total number of trees, which constitutes the sample, for abscissa. The other curves shown in this figure were constructed in like manner.

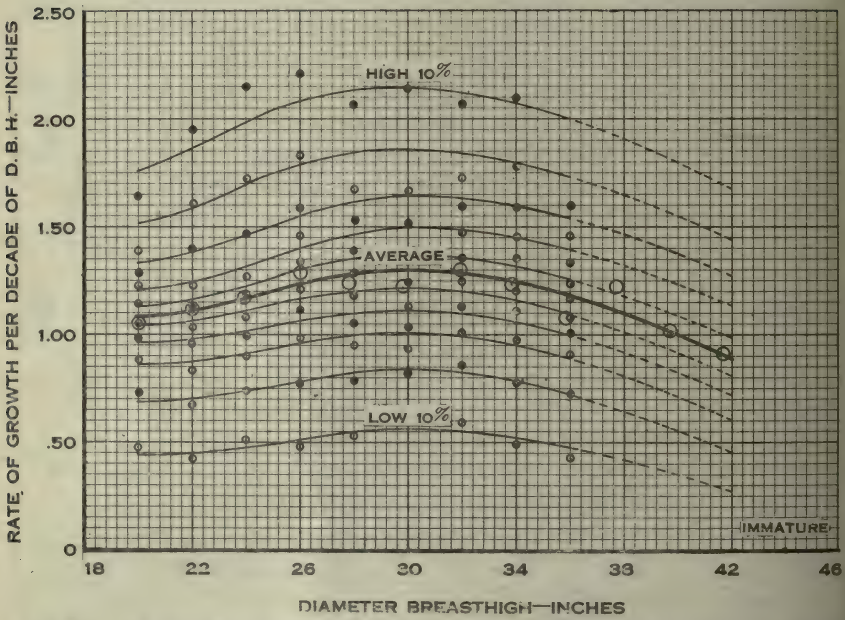


FIG. 85.—Curves obtained directly from Fig. 83, showing rates of growth per decade of diameter breasthigh, of immature trees. These curves show rates for the lowest ten per cent of trees, next to the lowest ten per cent, etc., to the highest ten per cent. The average curve is plotted from averages of all rates for each diameter class.

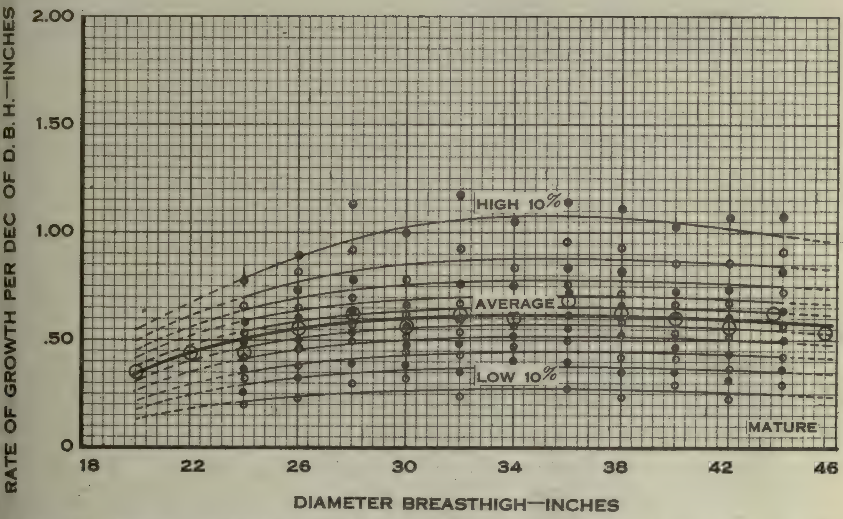


Fig. 86.—Curves obtained directly from Fig. 84, showing rates of growth per decade of diameter breasthigh, of mature trees. These curves show rates for the lowest ten per cent of trees, next to the lowest ten per cent, etc., to the highest ten per cent. The average curve is plotted from averages of all rates for each diameter class.

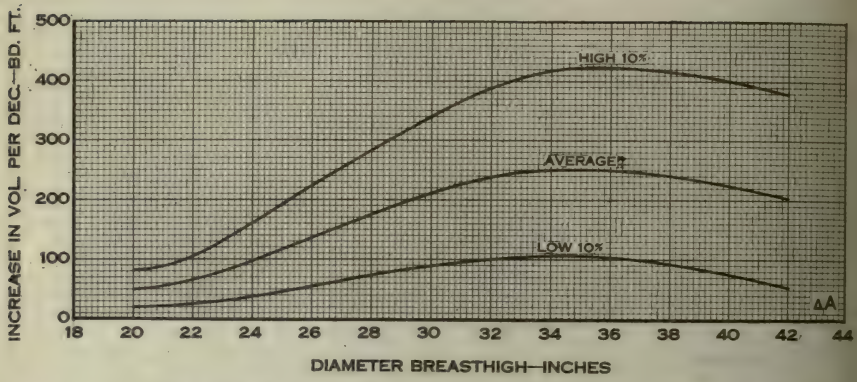


FIG. 87.—Curves showing increase in merchantable volume per decade of immature trees of different diameters breasthigh. These curves are constructed by plotting the increment of volume from curve A, the total merchantable volume curve, corresponding to the increment of growth in diameter breasthigh as shown in Fig. 83 for immature trees of different diameters.

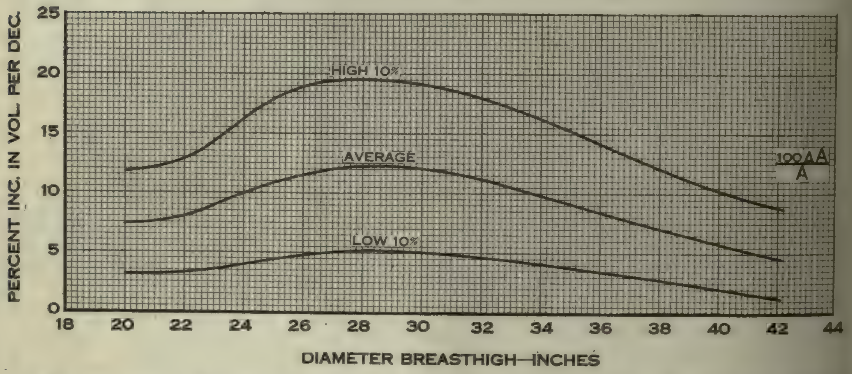


FIG. 88.—Curves showing per cent of increase in merchantable volume per decade, of immature trees of different diameters. These curves are obtained by expressing the values shown in Fig. 87 in per cent of merchantable volume, or $\frac{\text{curve}}{\text{curve A}} \times 100 =$ per cent increase in volume per decade.

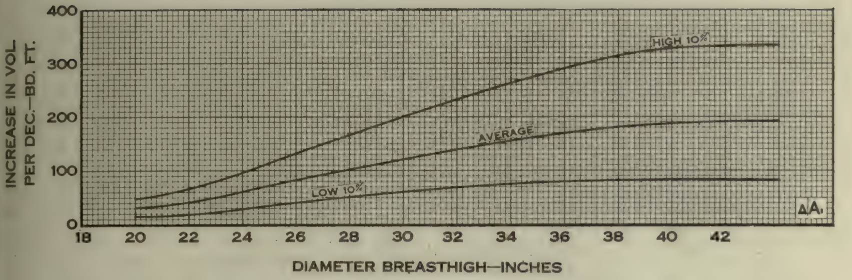


FIG. 89.—Curves showing increase in merchantable volume per decade of mature trees of different diameters breasthigh. These curves are constructed by plotting the increment of volume from curve A_1, the total merchantable volume curve, corresponding to the increase in grown in diameter breasthigh, as shown in Fig. 84, for mature trees of different diameters.

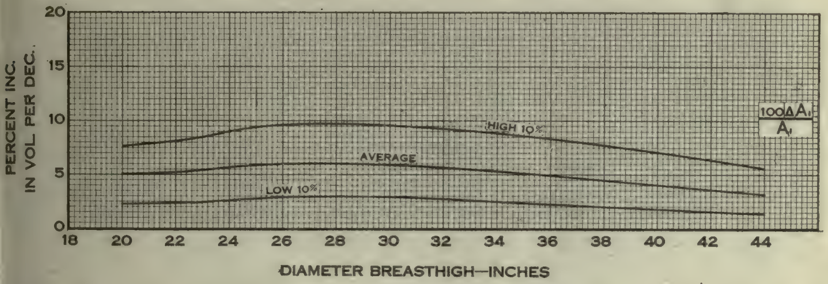


FIG. 90.—Curves showing per cent of increase in merchantable volume per decade, of mature trees of different diameters. These curves are obtained by expressing the values shown in Fig. 89 in per cent of merchantable volume, or $\frac{\text{curve } \triangle A_1}{\text{curve } A_1} \times 100 =$ per cent increase in volume per decade.

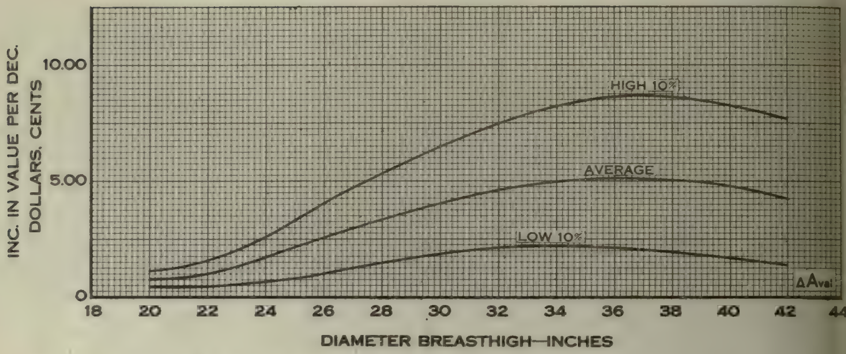


FIG. 91.—Curves showing increase in value per decade in dollars and cents of immature trees of different diameters breasthigh. These curves are constructed by plotting the increment of value from "B," the total value curve, corresponding to the increment of growth in diameter breasthigh shown in Fig. 83, for trees of different diameters.

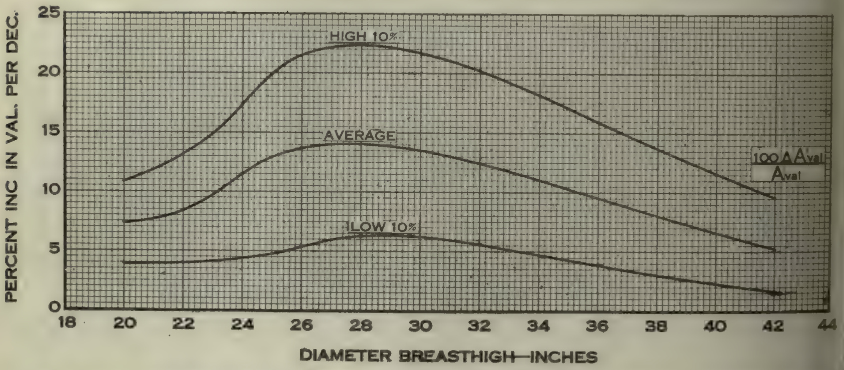


FIG. 92.—Curves showing per cent increase in value per decade of immature trees of different diameters breasthigh. These curves are obtained by expressing the values shown in Fig. 91 in per cent of total value of trees of different diameters, or

$\frac{\text{curve } \triangle \text{ B}}{\text{curve B}} \times 100 =$ per cent increase in value, in dollars and cents, per decade of growth.

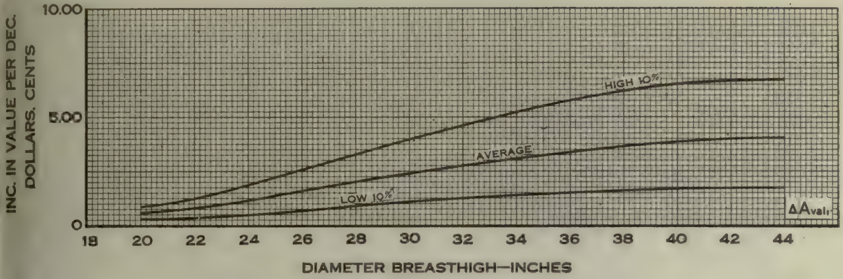


FIG. 93.—Curves showing increase in value per decade in dollars and cents of nature trees of different diameters breasthigh. These curves are constructed by lotting the increment of value from "B_1," the total value curve, corresponding to the ncrement of growth in diameter breasthigh shown in Fig. 84, for trees of different iameters.

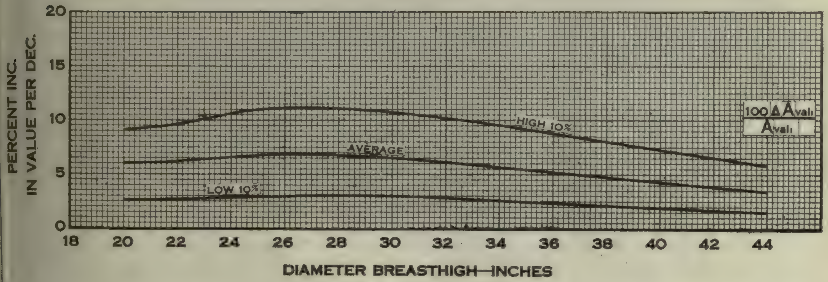


FIG. 94.—Curves showing per cent increase in value per decade of mature trees of fferent diameters breasthigh. These curves are obtained by expressing the values own in Fig. 93 in per cent of total value of trees of different diameters, or

$$\frac{\text{rve } \triangle B_1}{\text{urve } B_1} \times 100 =$$ per cent increase in value, in dollars and cents, per decade of growth.

FOR BUTT LOGS.

Volume.

Curves showing average total volume in board feet contained in 16′ butt logs from immature western yellow pine trees of different diameters breasthigh.

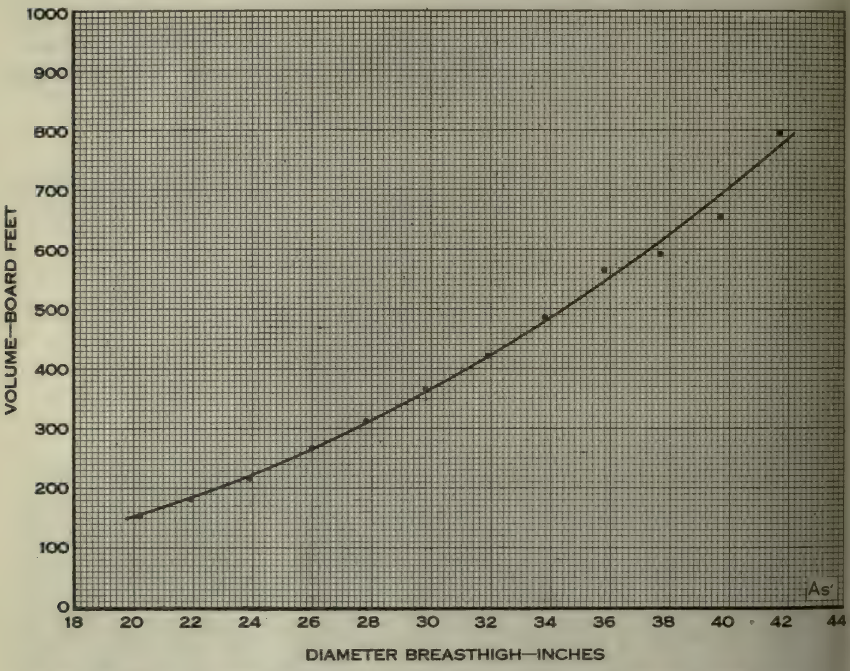


FIG. 95.—Total volume in board feet as shown by the Spaulding Log Rule.

Curves showing average total volume in board feet contained in 16′ butt logs from mature western yellow pine trees of different diameters breasthigh.

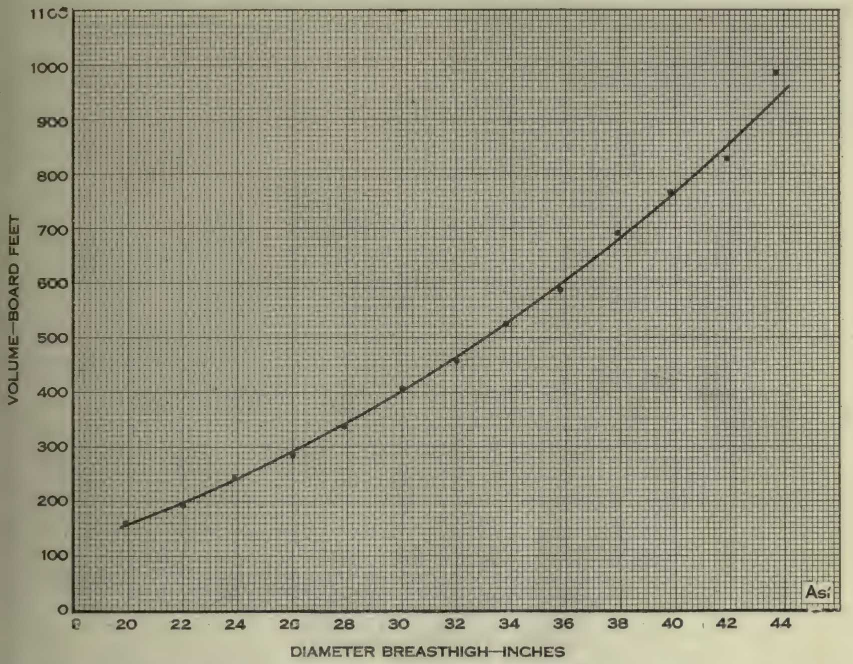


FIG. 96.—Total volume in board feet as shown by the Spaulding Log Rule.

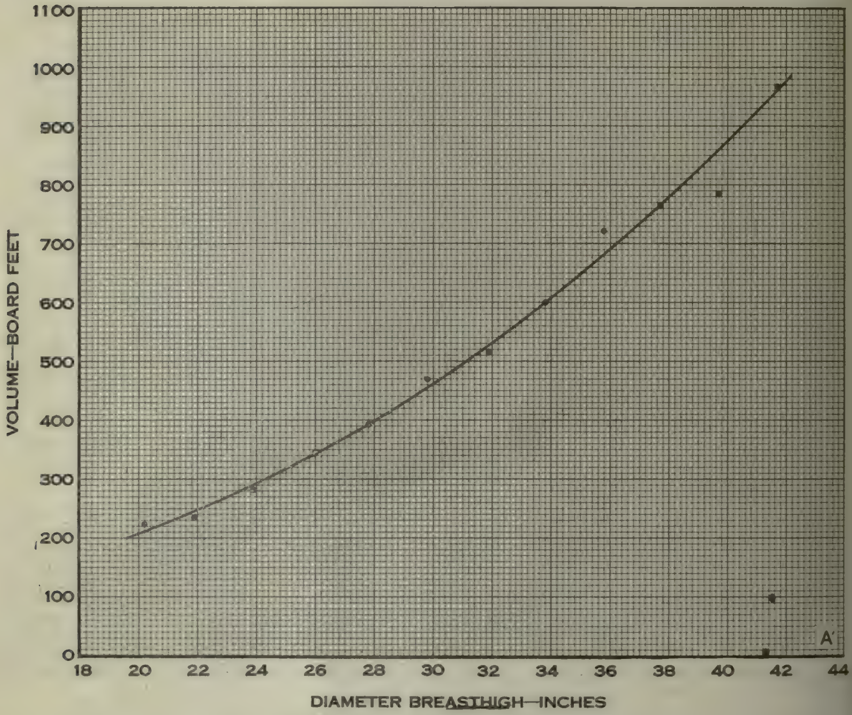


FIG. 97.—Total volume in board feet actually "sawed out" at mill.

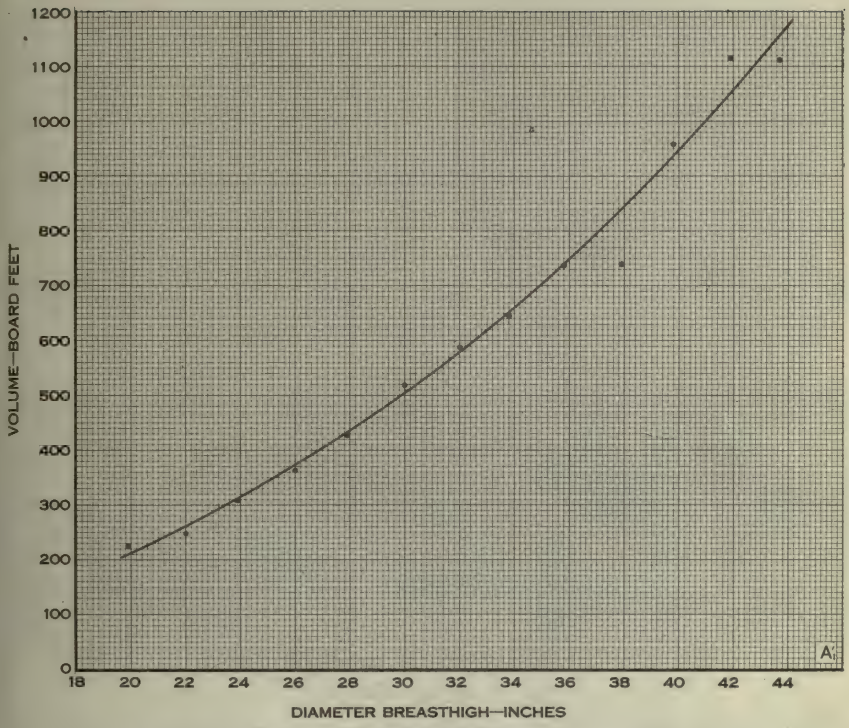


FIG. 98.—Total volume in board feet actually "sawed out" at mill.

Curves showing average volume in board feet of each grade actually "sawed out" at mill, from 16′ butt logs of immature western yellow pine trees of different diameters breasthigh.

High Grades Sawed From Butt Logs of Immature Trees.

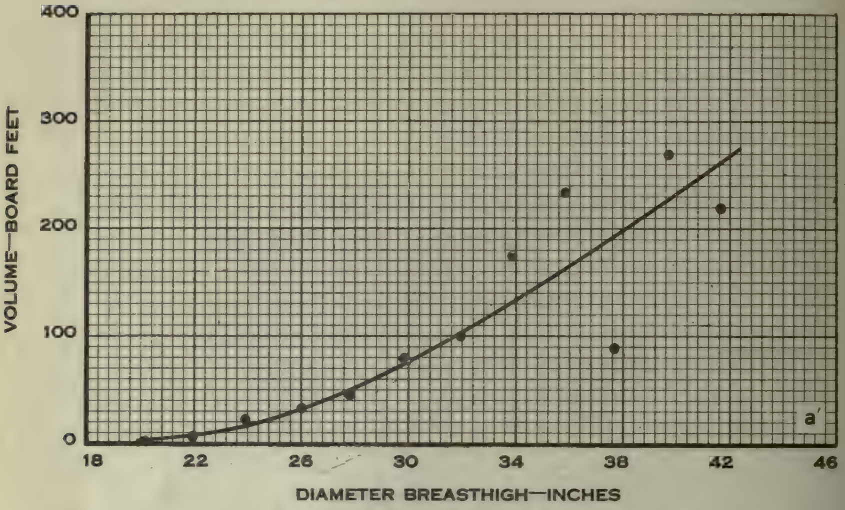


FIG. 99.—C. and Better, 6/4″.

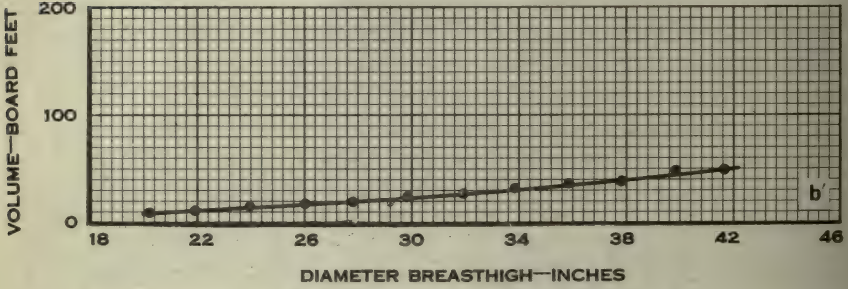


FIG. 100.—Moulding Stock.

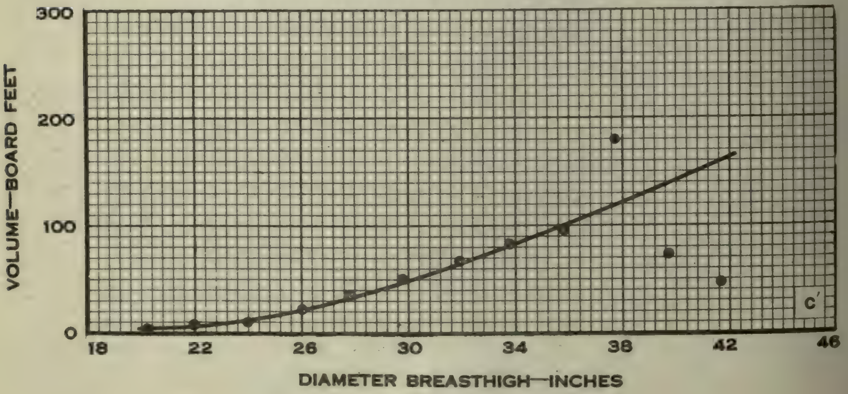


FIG. 101.—No. 1 Shop, 6/4″.

Curves showing average volume in board feet of each grade actually "sawed out" at mill, from 16′ butt logs of mature western yellow pine trees of different diameters breasthigh.

High Grades Sawed From Butt Logs of Mature Trees.

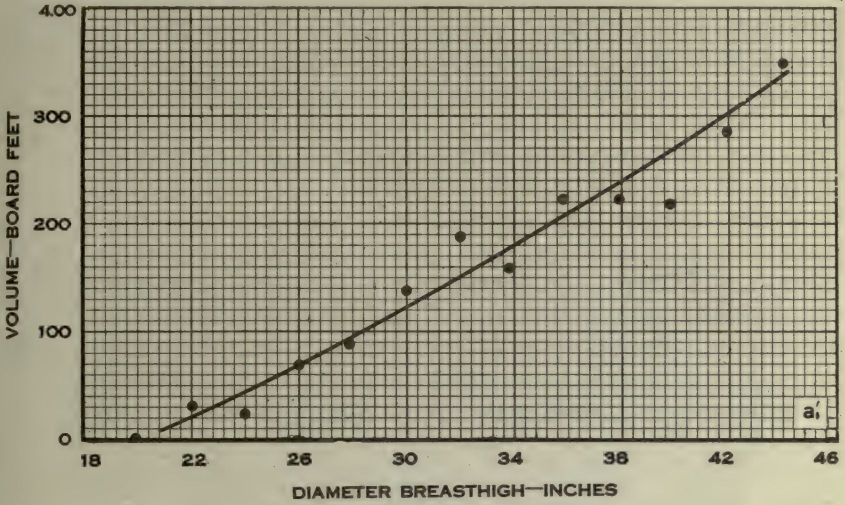


FIG. 102.—C. and Better, 6/4″.

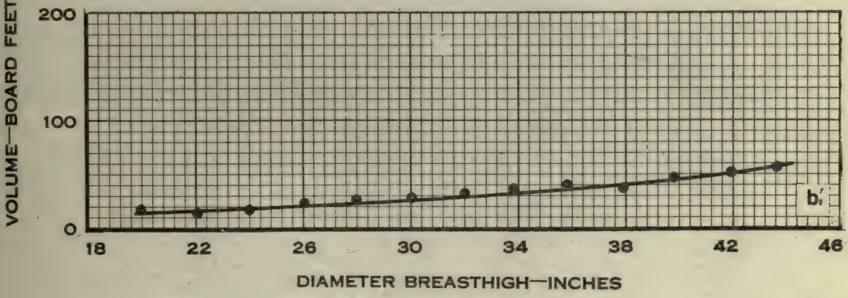


FIG. 103.—Moulding Stock.

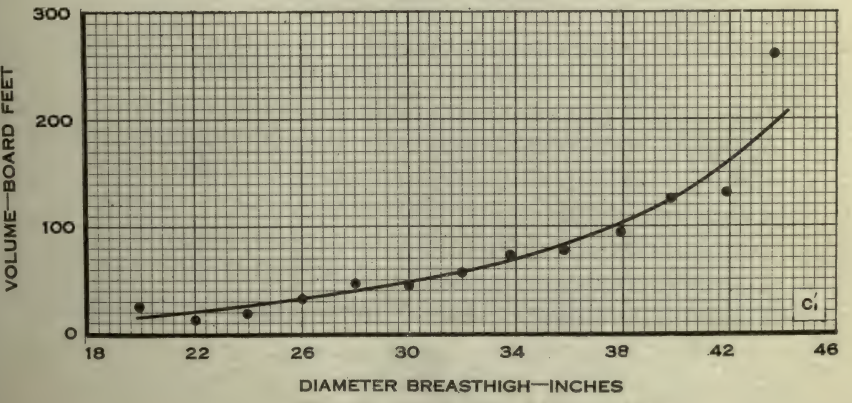


FIG. 104.—No. 1 Shop, 6/4″.

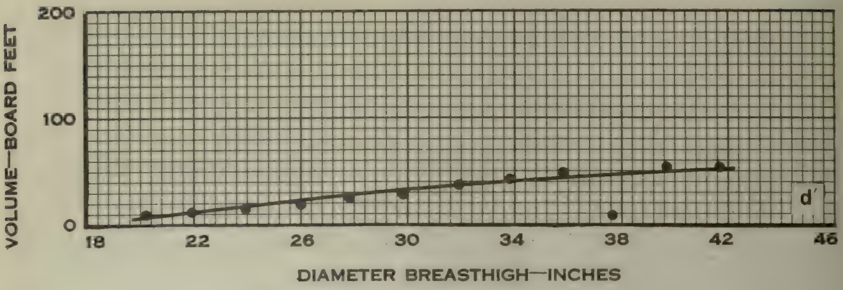


FIG. 105.—D. Select and Better, 1″.

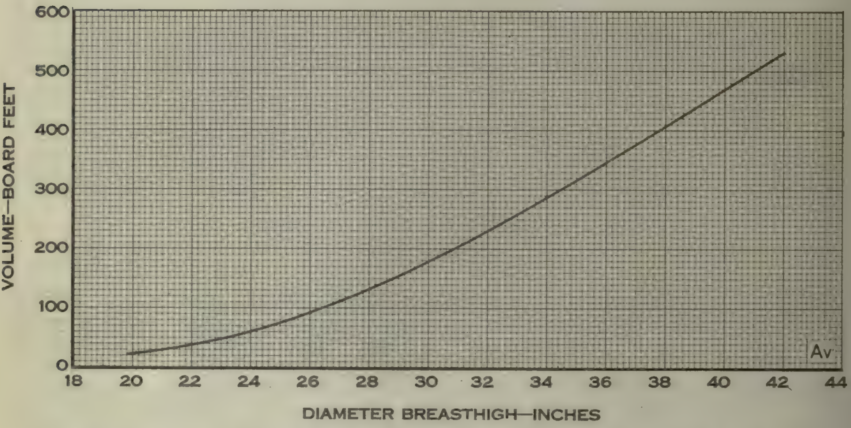


FIG. 106.—Total of high grades sawed from butt logs of immature trees.

$$a' + b' + c' + d' = Av'.$$

Intermediate Grades Sawed From Butt Logs of Immature Trees.

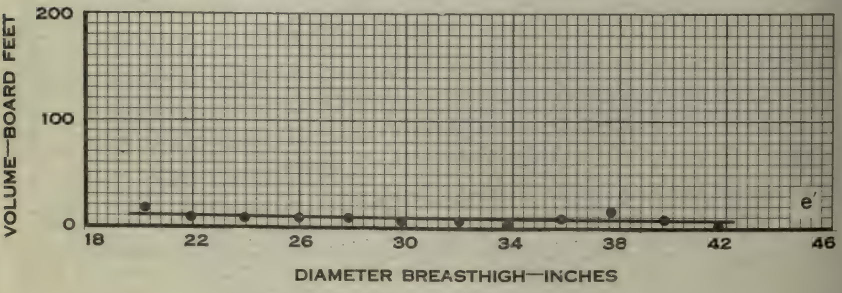


FIG. 107.—No. 1 Common, 1″.

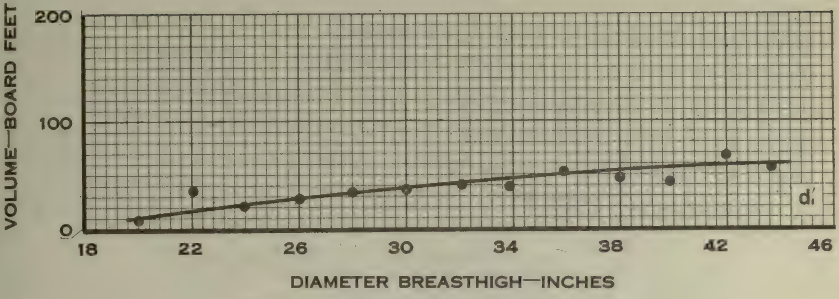


FIG. 108.—D. Select and Better, 1".

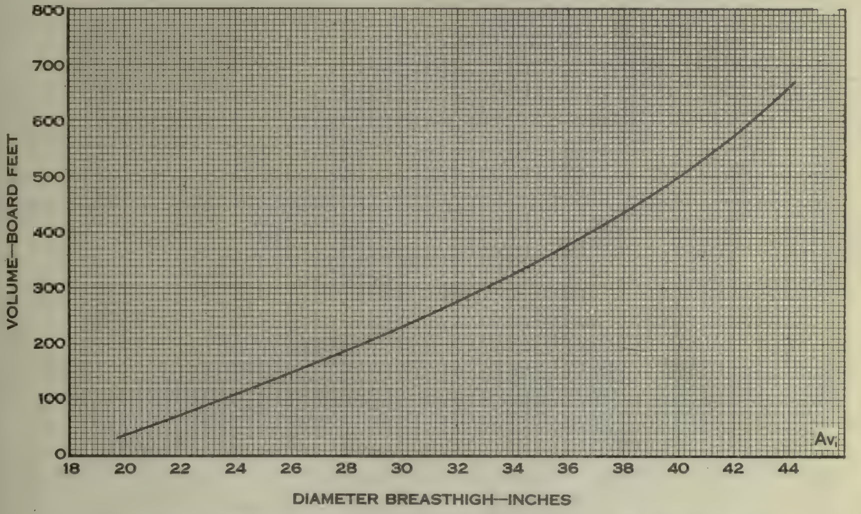


FIG. 109.—Total of high grades sawed from butt logs of mature trees.

$$a'_1 + b'_1 + c'_1 + d'_1 = Av'_1.$$

Intermediate Grades Sawed From Butt Logs of Mature Trees.

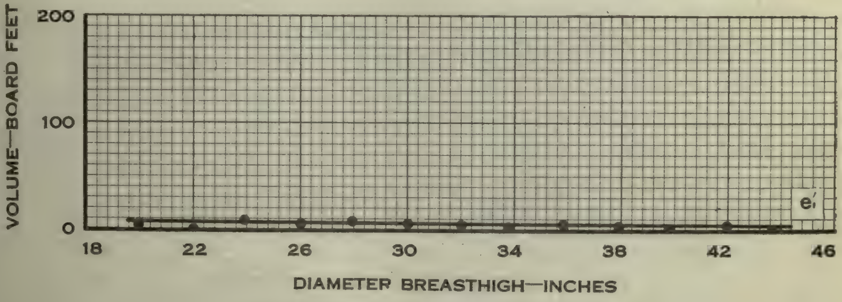


FIG. 110.—No. 1 Common, 1".

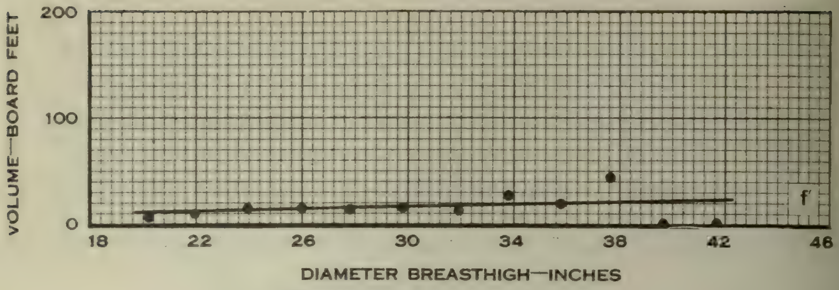


FIG. 111.—No. 2 Common, 1″.

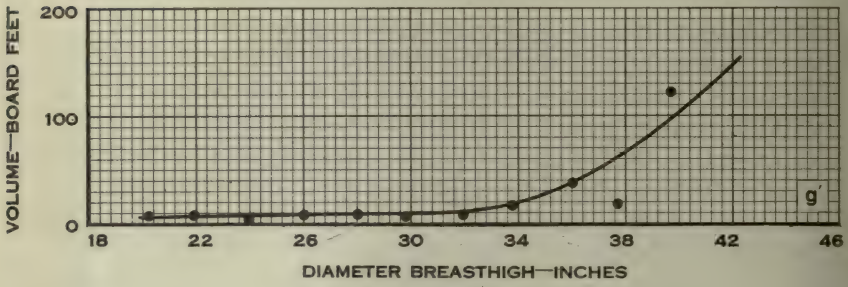


FIG. 112.—Shop 1″.

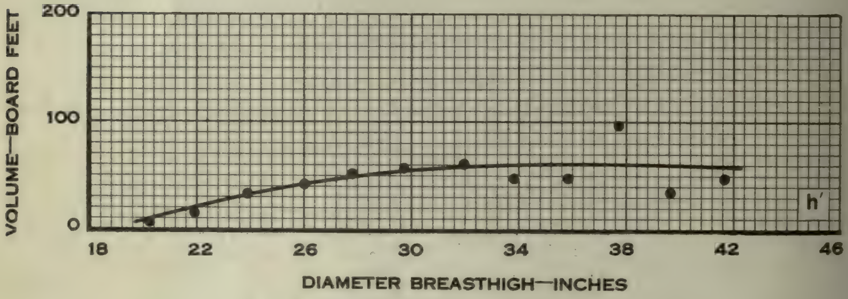


FIG. 113.—No. 2 Shop, 6/4″.

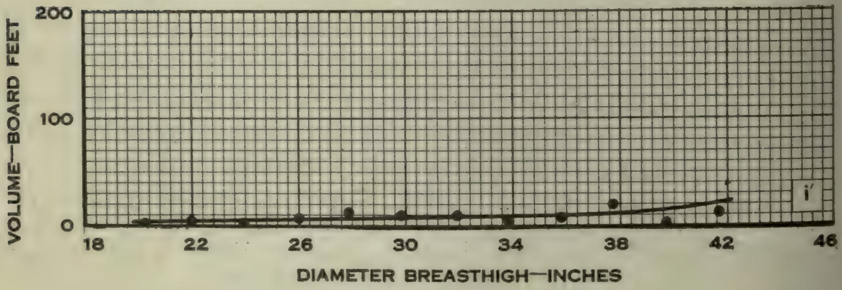


FIG. 114.—Shims.

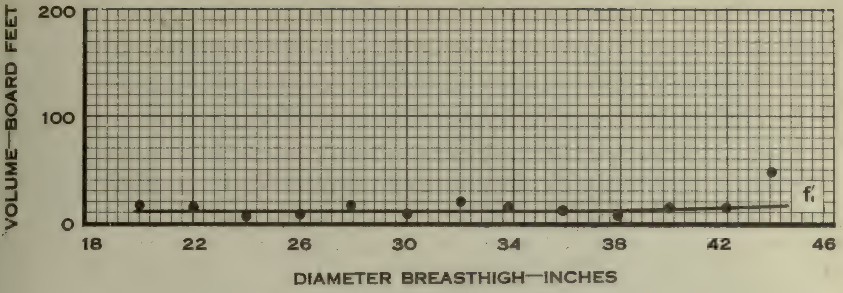


Fig. 115.—No. 2 Common, 1″.

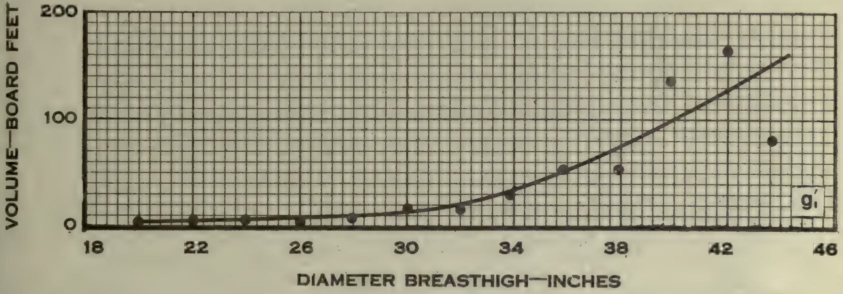


Fig. 116.—Shop 1″.

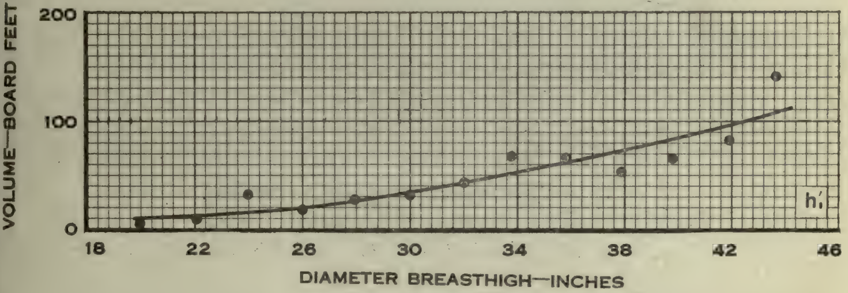


Fig. 117.—No. 2 Shop, 6/4″.

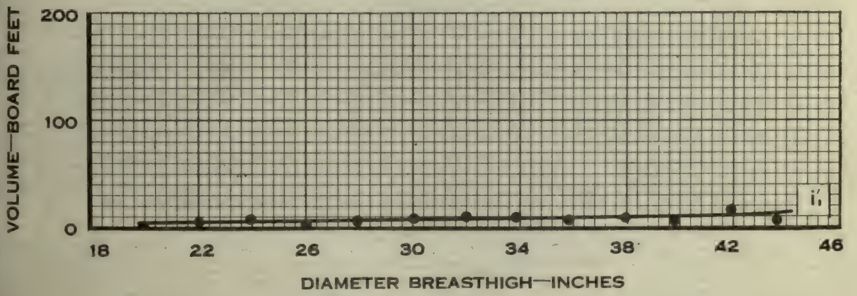


Fig. 118.—Shims.

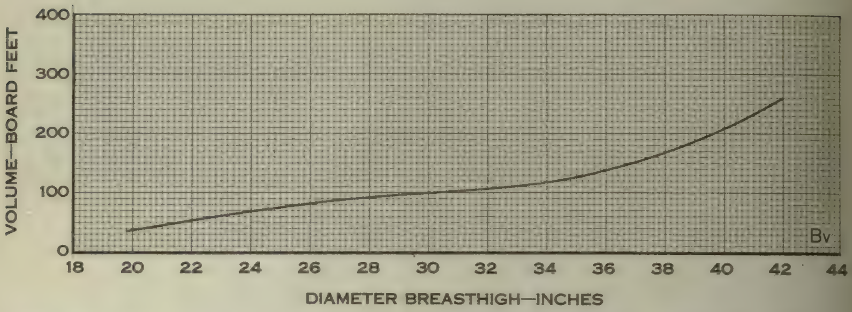


FIG. 119.—Total of intermediate grades sawed from butt logs of immature trees.

$$e' + f' + g' + h' + i' = Bv'.$$

Low Grades Sawed From Butt Logs of Immature Trees.

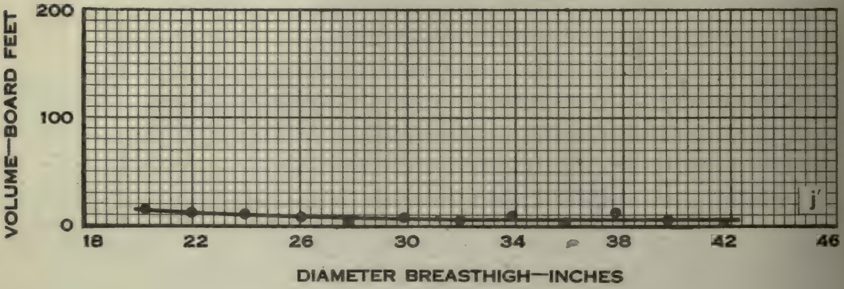


FIG. 120.—Box 1″.

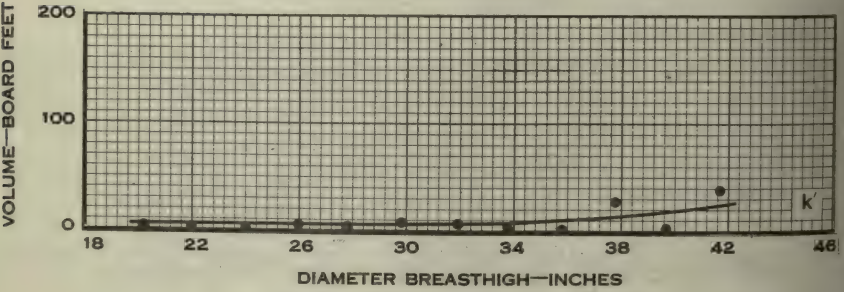


FIG. 121.—Culls.

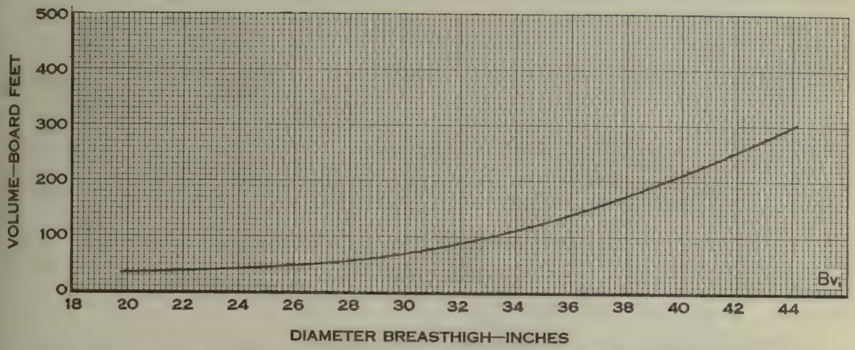


FIG. 122.—Total of intermediate grades sawed from butt logs of mature trees.

$$e'_1 + f'_1 + g'_1 + h'_1 + i'_1 = Bv'_1.$$

Low Grades Sawed From Butt Logs of Mature Trees.

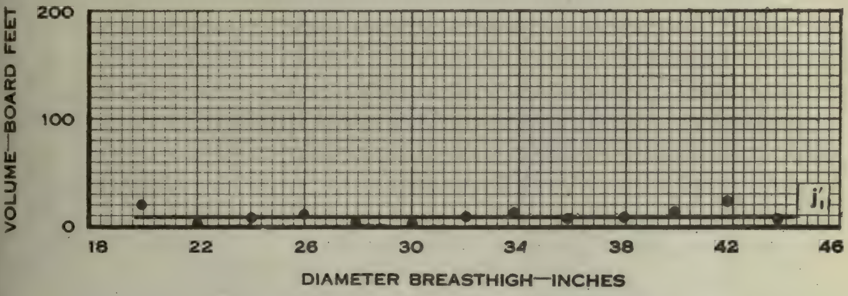


FIG. 123.—Box 1″.

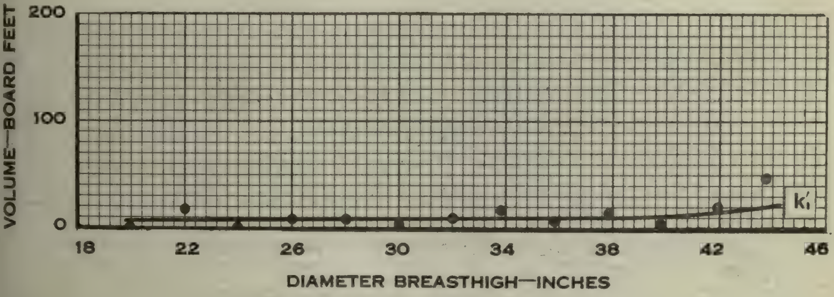


FIG. 124.—Culls.

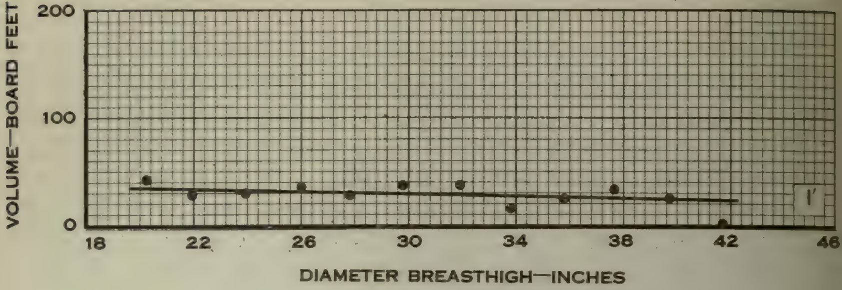


FIG. 125.—Box 6/4″.

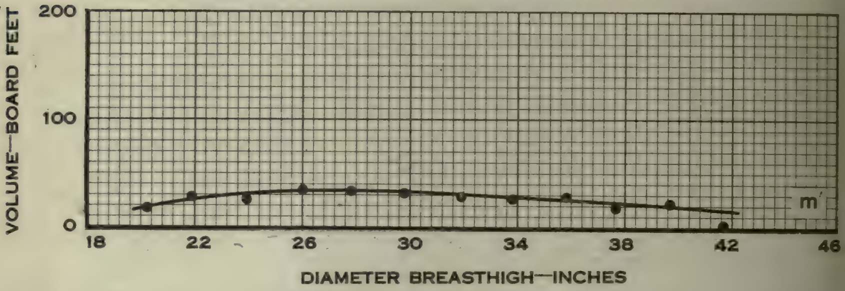


FIG. 126.—No. 3 Shop, 6/4″.

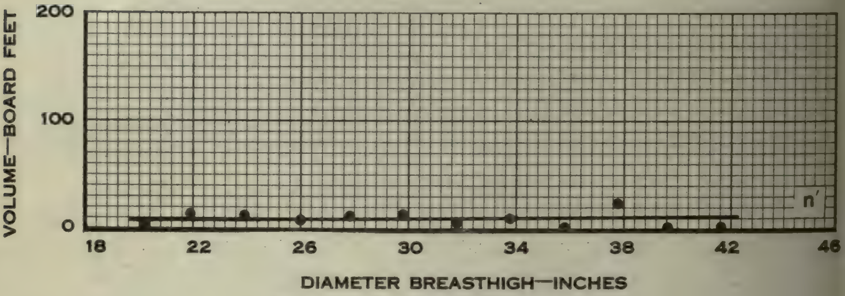


FIG. 127.—No. 3 Common, 1″.

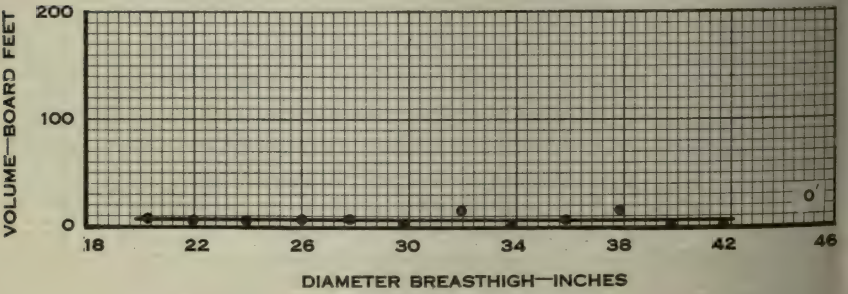


FIG. 128.—Plank 3″.

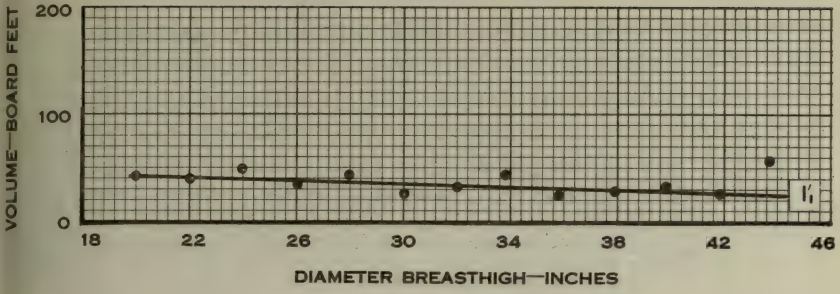


FIG. 129.—Box 6/4″.

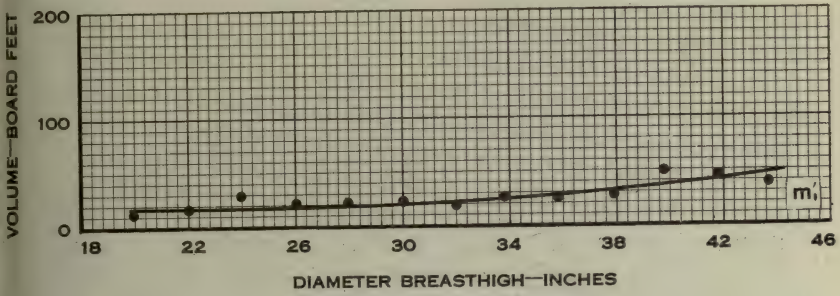


FIG. 130.—No. 3 Shop, 6/4″.

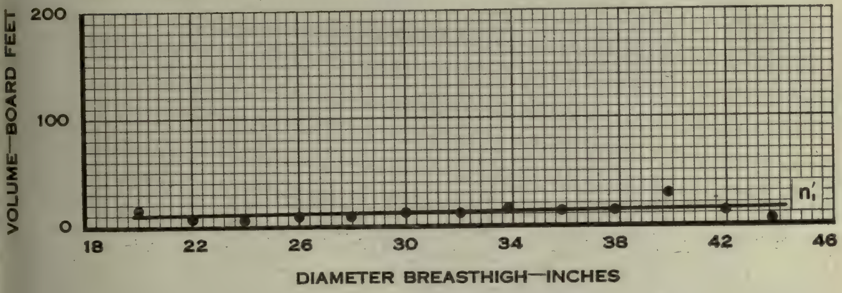


FIG. 131.—No. 3 Common, 1″.

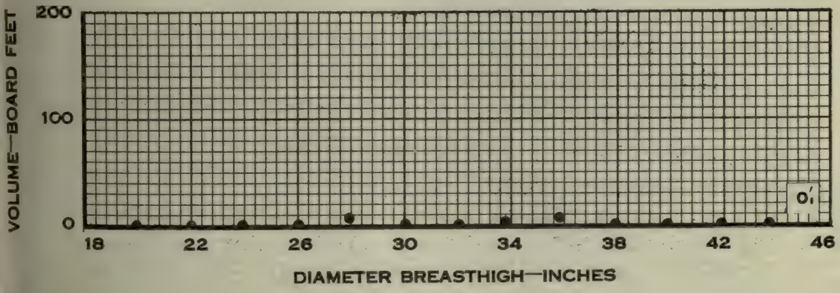


FIG. 132.—Plank 3″.

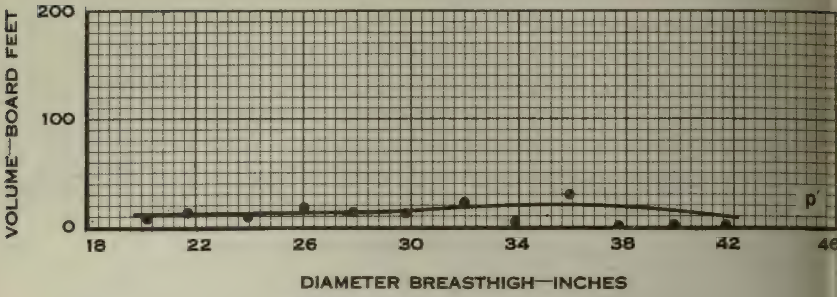


FIG. 133.—4″ x 4″ and Larger.

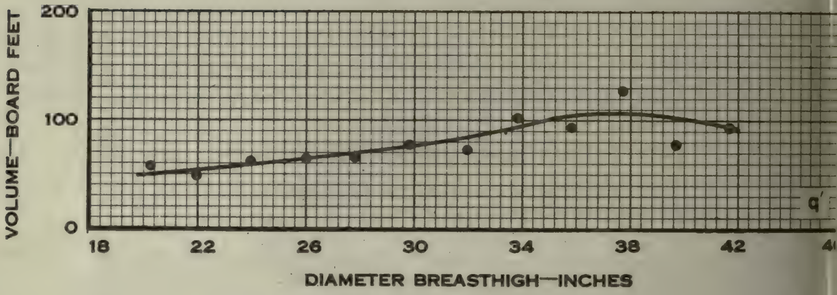


FIG. 134.—2″ x 4″ and Wider, No. 1 Dim.

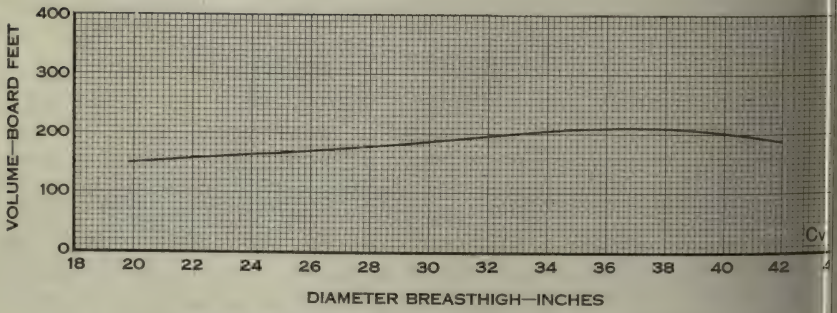


FIG. 135.—Total of low grades sawed from butt logs from immature trees.

$$j' + k' + l' + m' + n' + o' + p' + q' = Cv'.$$

NOTE.—$Av' + Bv' + Cv' = A'$ lumber actually sawed out at mill. Curve A′ is shown in Fig. 97.

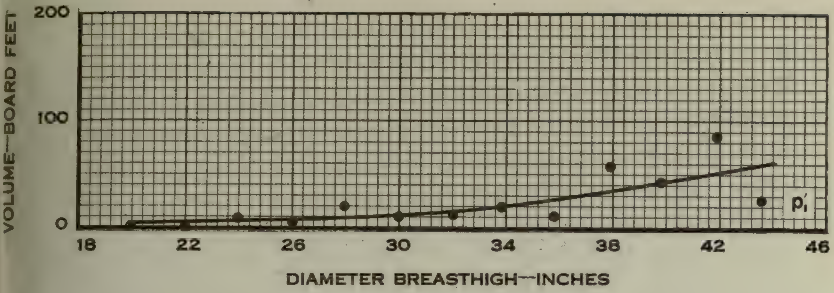


FIG. 136.—4″ x 4″ and Larger.

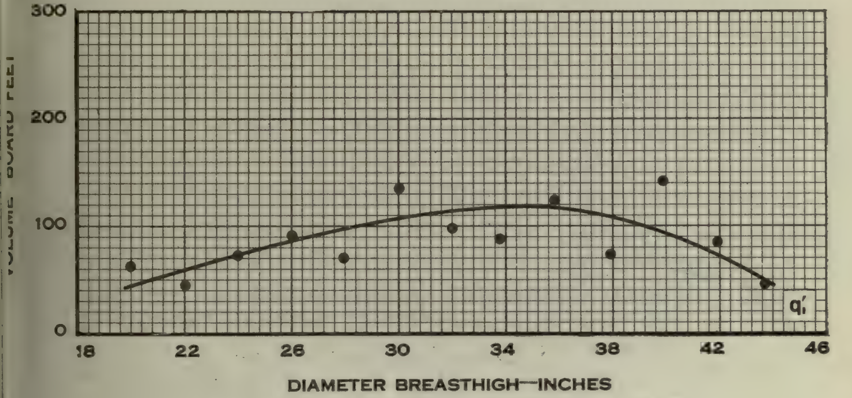


FIG. 137.—2″ x 4″ and Wider, No. 1 Dim.

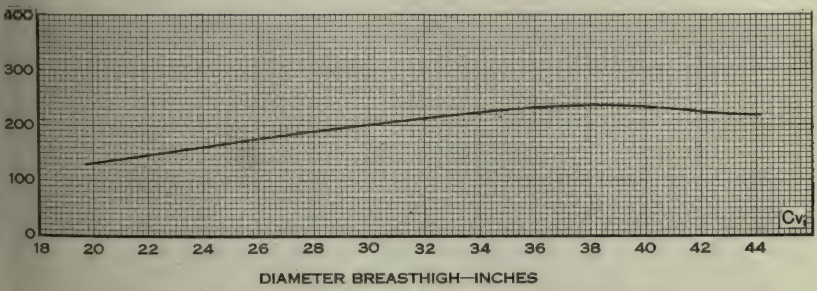


FIG. 138.—Total of low grades sawed from butt logs from mature trees.

$$j_1' + k_1' + l_1' + m_1' + n_1' + o_1' + p_1' + q_1' = Cv_1'.$$

NOTE.—$Av_1' + Bv_1' + Cv_1' = A_1'$, lumber actually sawed out at mill. Curve A_1' is hown in Fig. 98.

Grades Sawed From 16′ Butt Logs of Immature Trees of Different Diameters Breasthigh, Expressed in Per Cent of Total "Sawed Out."

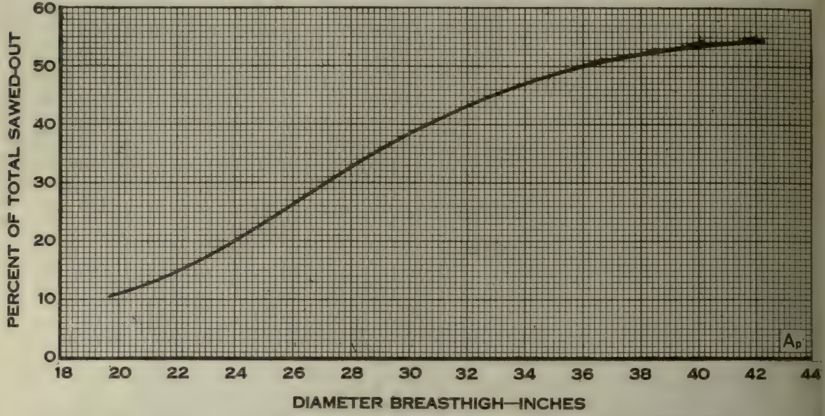


FIG. 139.—High grades. $\frac{100\,Av'}{A'} = Ap'$.

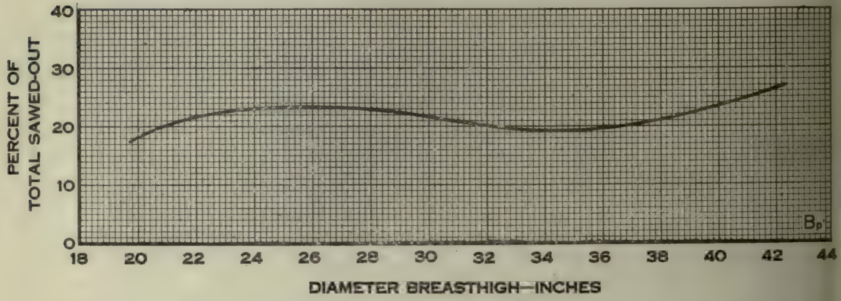
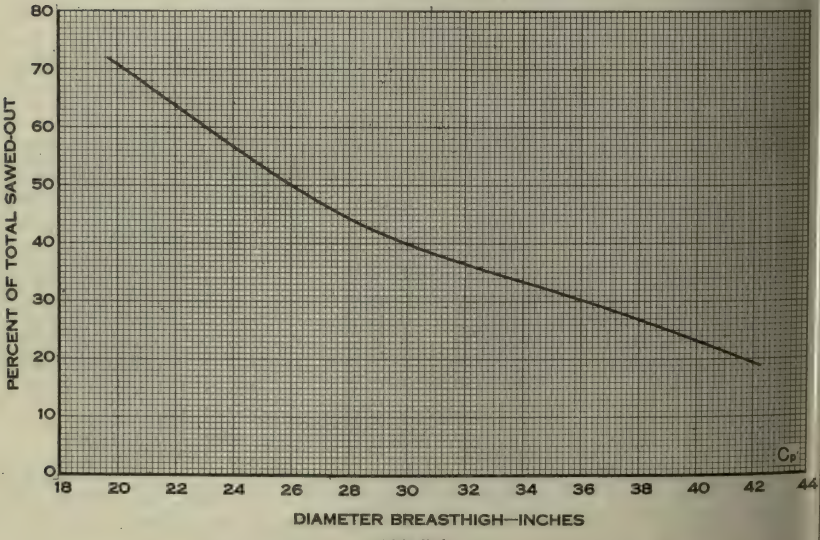


FIG. 140.—Intermediate grades. $\frac{100\,Bv'}{A'} = Bp'$.



100 Cv'

Grades Sawed From 16′ Butt Logs of Mature Trees of Different Diameters Breasthigh, Expressed in Per Cent of Total "Sawed Out."

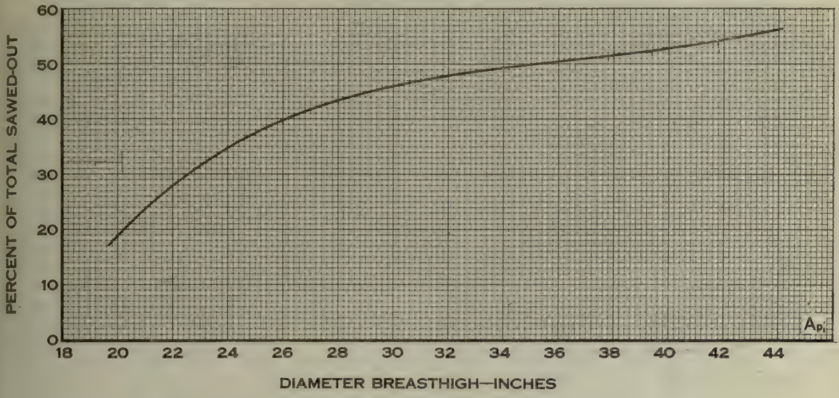


FIG. 142.—High grades. $\frac{100\,Av_1'}{A_1'} = Ap_1'$.

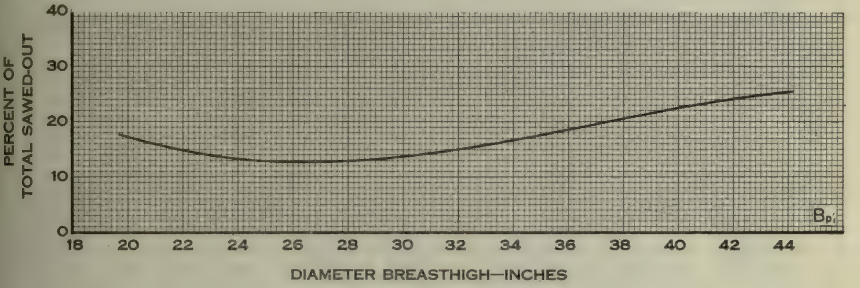


FIG. 143.—Intermediate grades. $\frac{100\,Bv_1'}{A_1'} = Bp_1'$.

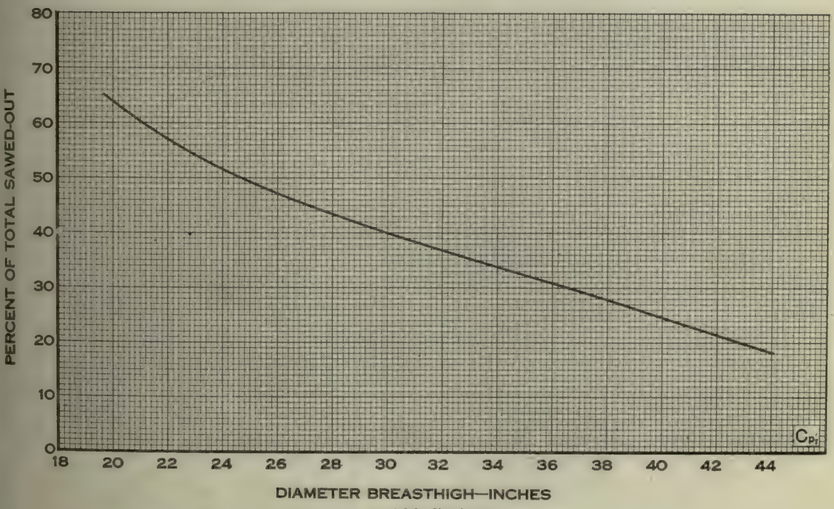


FIG. 144.—Low grades. $\frac{100\,Cv_1'}{A_1'} = Cp_1'$.

Value.

Value of Grades Sawed From 16′ Butt Logs of Immature Trees of Different Diameters Breasthigh, Expressed in Dollars and Cents.

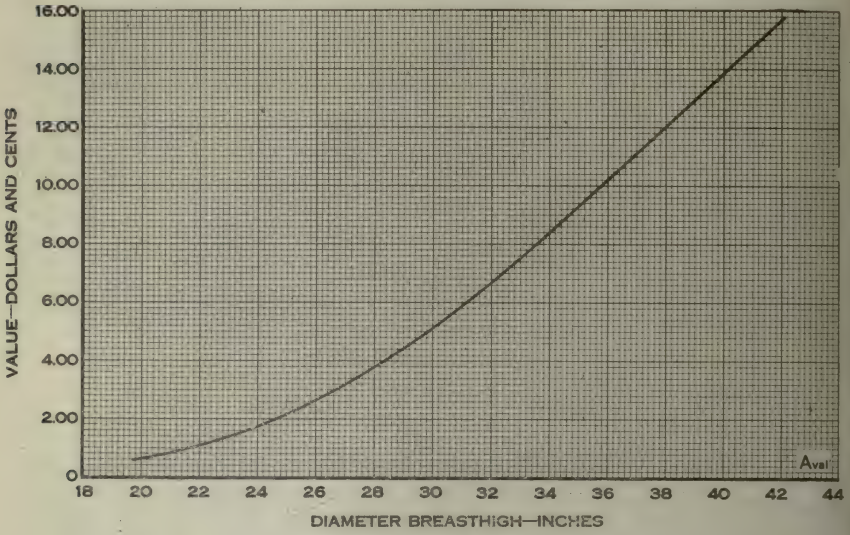


FIG. 145.—High grades.

$$.032a' + .030b' + .027c' + .025d' = Aval'.$$

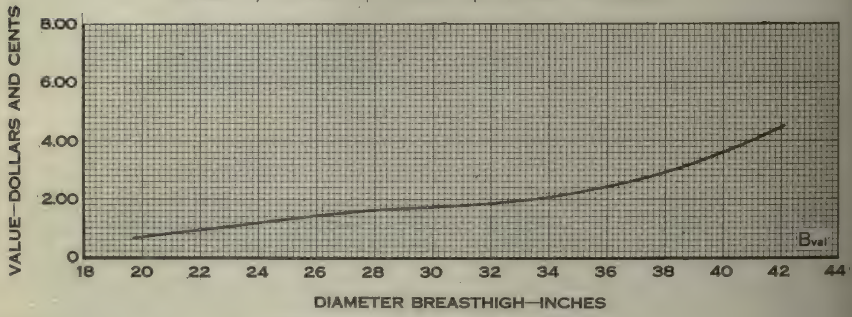


FIG. 146.—Intermediate grades.

$$.022e' + .018f' + .018g' + .018h' + .007i' = Bval'.$$

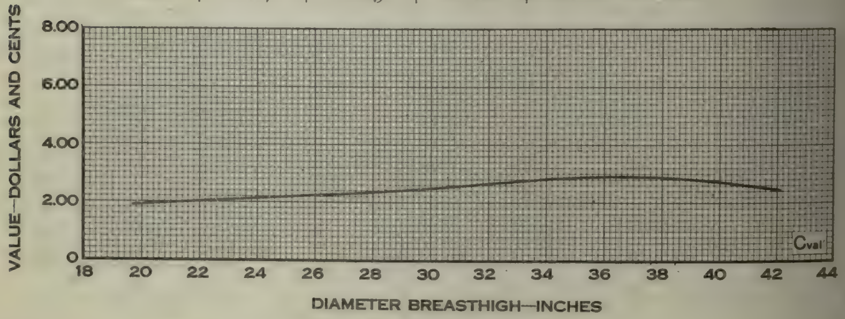


FIG. 147.—Low grades.

$$.009j' + .007k' + \quad .015q' = Cval'$$

Value of Grades Sawed From 16′ Butt Logs of Mature Trees of Different Diameters Breasthigh, Expressed in Dollars and Cents.

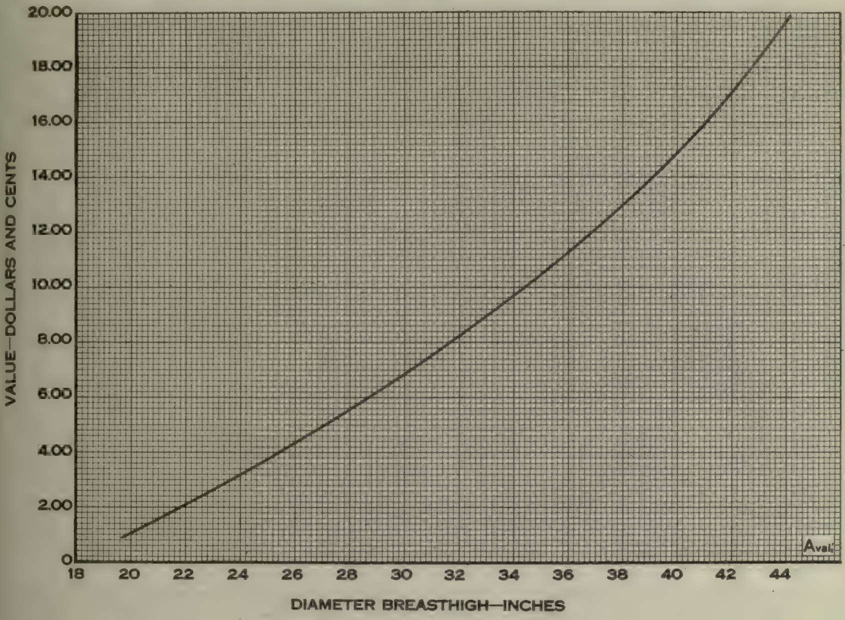


FIG. 148.—High grades.

$$.032a_1' + .030b_1' + .027c_1' + .025d_1' = Aval_1'.$$

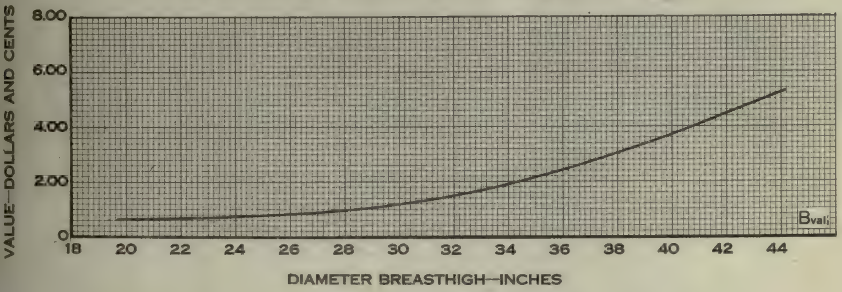


FIG. 149.—Intermediate grades.

$$.022e_1' + .018f_1' + .018g_1' + .018h_1' + .007i_1' = Bval_1'.$$

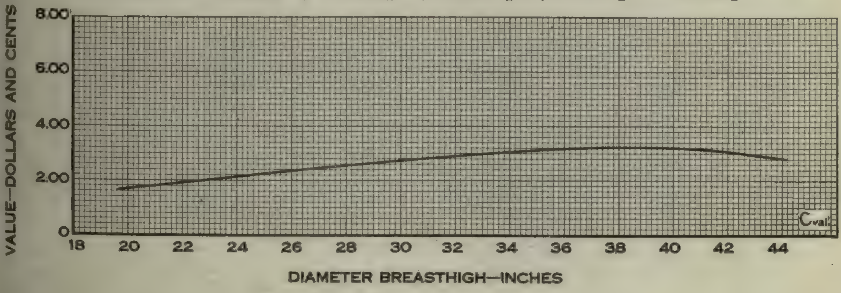


FIG. 150.—Low grades.

$$.009j_1' + .007k_1' + \text{--------} .015q_1' = Cval_1'.$$

FOR TOP LOGS.

Volume.

Curves showing average volume in board feet of each grade actually "sawed out" at mill, from top logs of immature western yellow pine trees of different diameters breasthigh.

High Grades Sawed From Top Logs of Immature Trees.

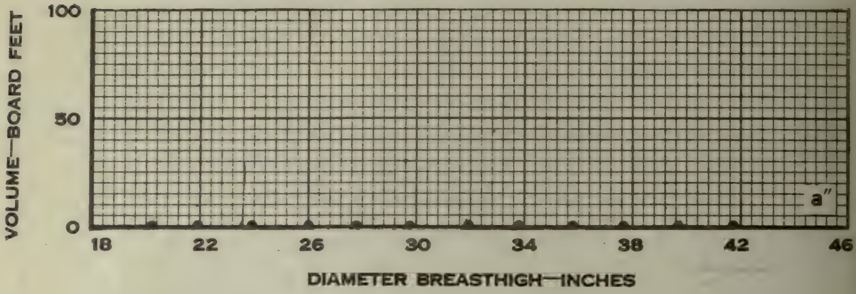


FIG. 151.—C. and Better, 6/4″.

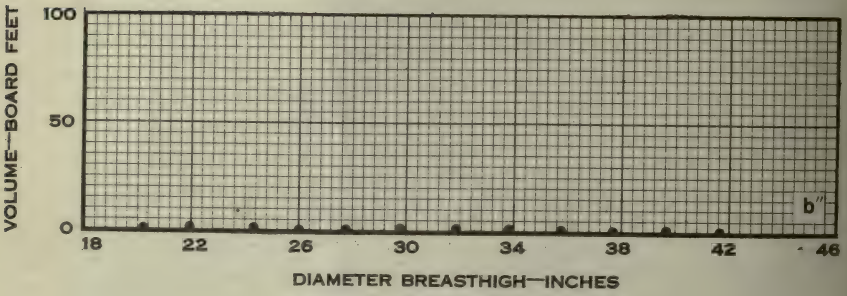


FIG. 152.—Moulding Stock.

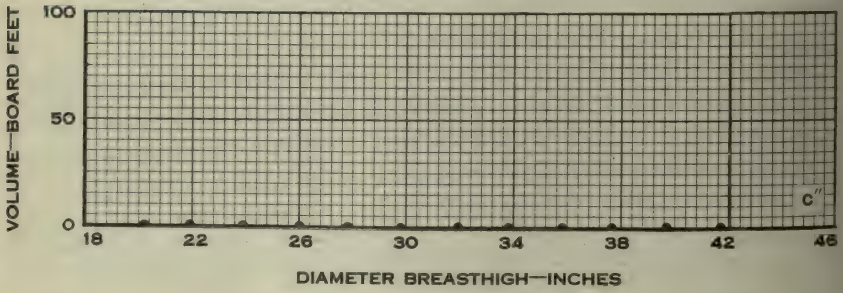


FIG. 153.—No. 1 Shop, 6/4″.

Curves showing average volume in board feet of each grade actually "sawed out" at mill, from top logs of mature western yellow pine trees of different diameters breasthigh.

High Grades Sawed From Top Logs of Mature Trees.

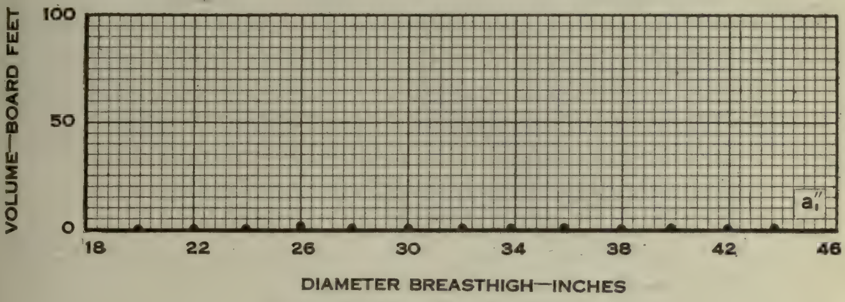


FIG. 154.—C. and Better, 6/4″.

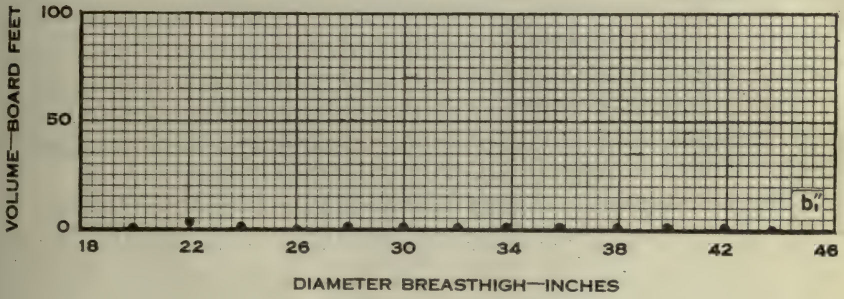


FIG. 155.—Moulding Stock.

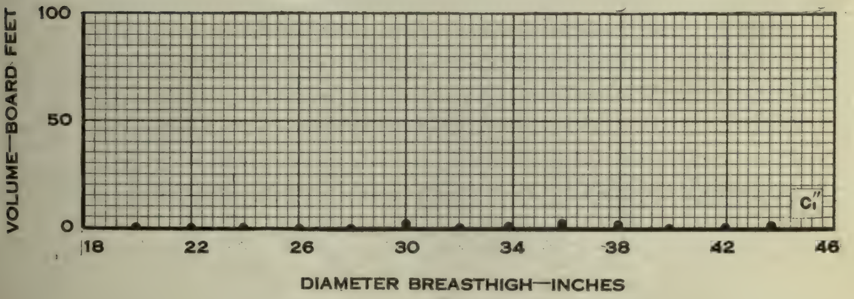


FIG. 156.—No. 1 Shop, 6/4″.

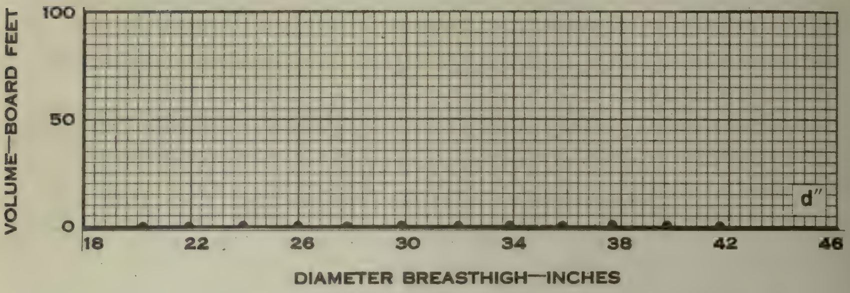


FIG. 157.—D. Select and Better, 1″.

Intermediate Grades Sawed From Top Logs of Immature Trees.

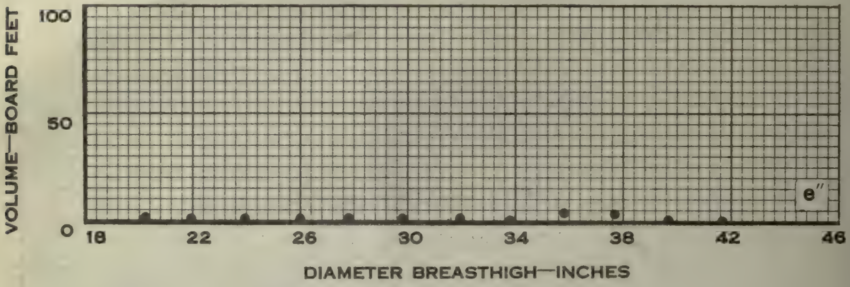


FIG. 158.—No. 1 Common, 1″.

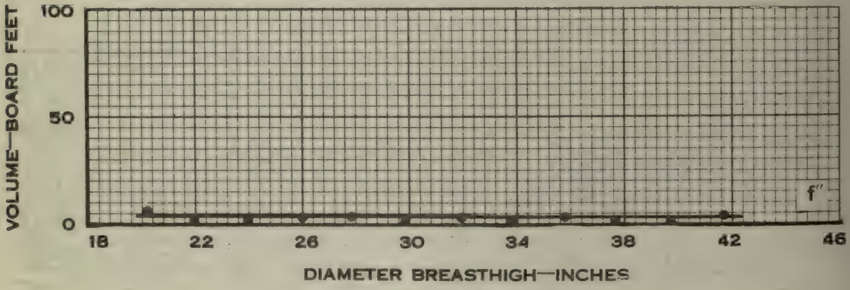


FIG. 159.—No. 2 Common, 1″.

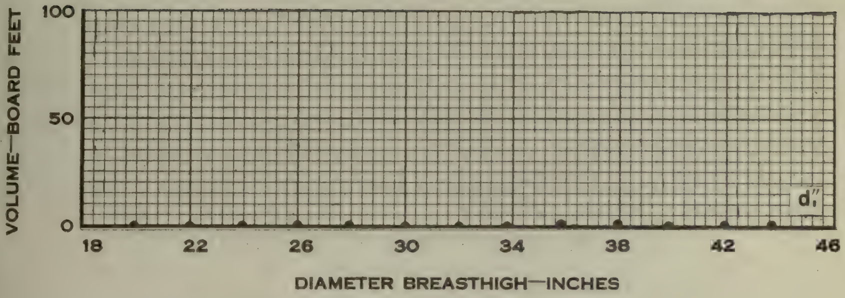


FIG. 160.—D. Select and Better, 1″.

Intermediate Grades Sawed From Top Logs of Mature Trees.

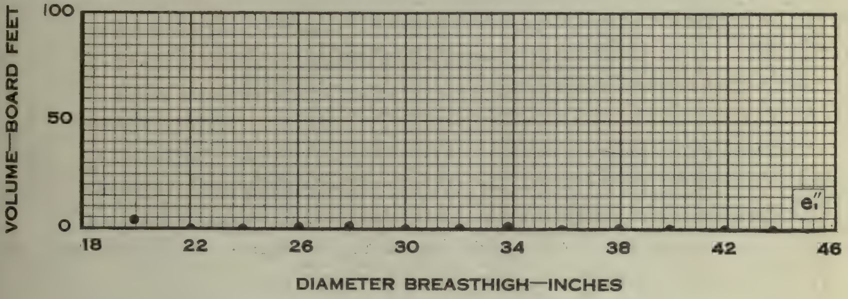


FIG. 161.—No. 1 Common, 1″.

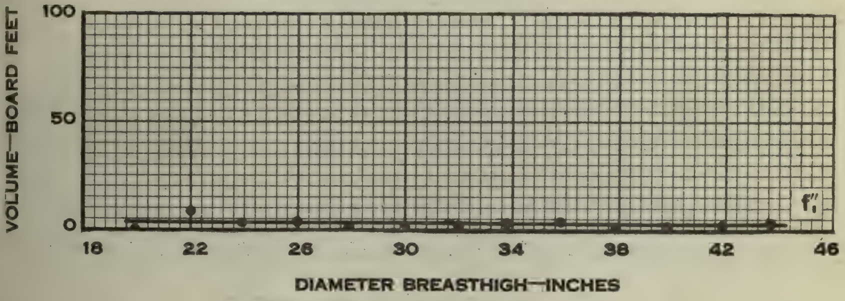


FIG. 162.—No. 2 Common, 1″.

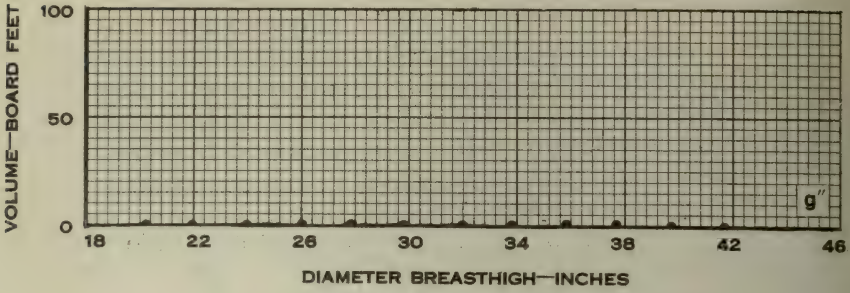


FIG. 163.—Shop, 1″.

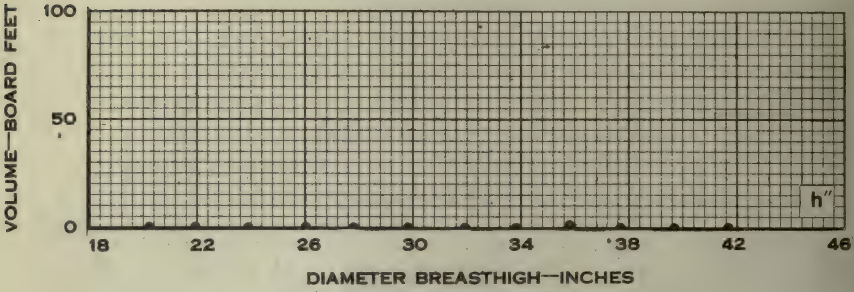


FIG. 164.—No. 2 Shop, 6/4″.

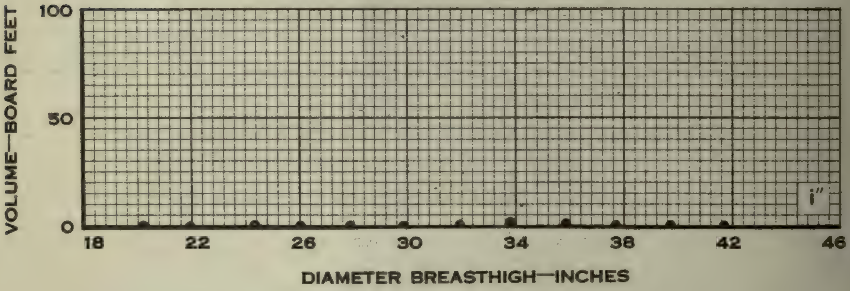


FIG. 165.—Shims.

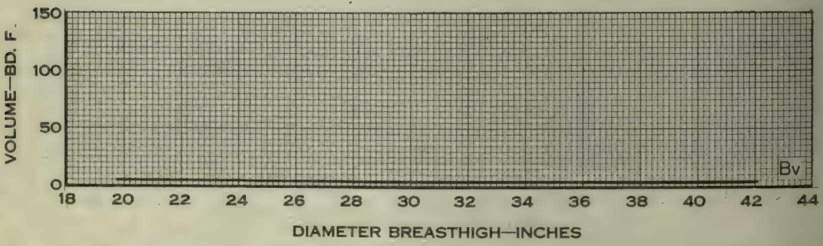


FIG. 166.—Total of intermediate grades sawed from top logs of immature trees.

$$e'' + f'' + g'' + h'' + i'' = Bv''.$$

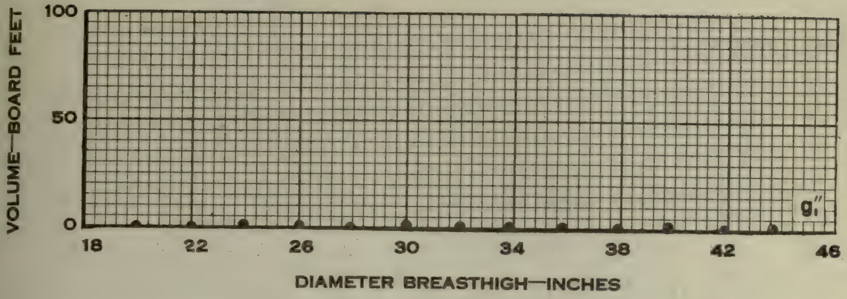


Fig. 167.—Shop, 1″.

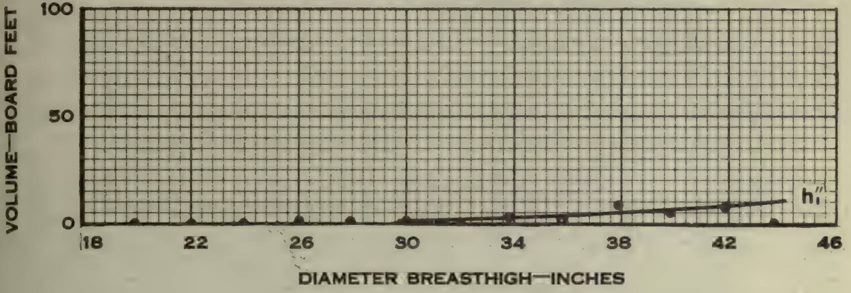


Fig. 168—No. 2 Shop, 6/4″.

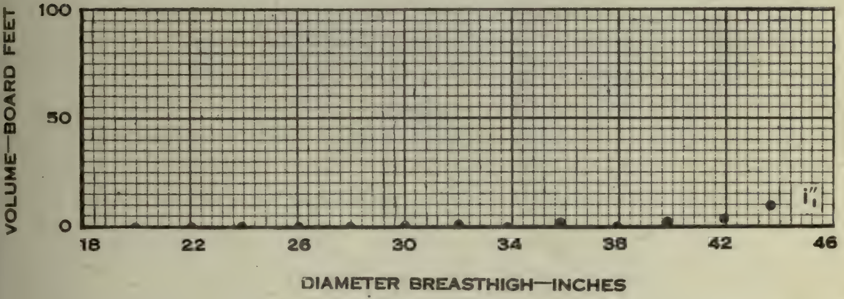


Fig. 169.—Shims.

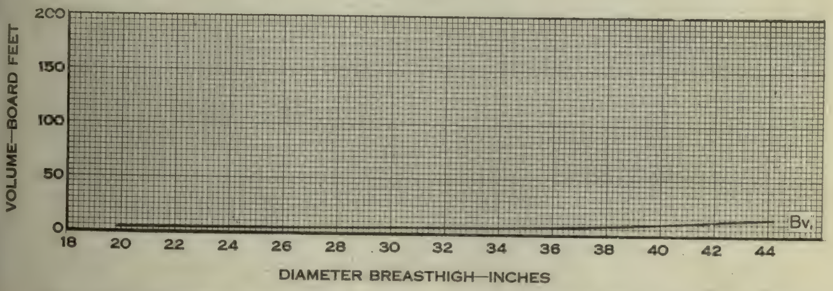


Fig. 170.—Total of intermediate grades sawed from top logs of mature trees.

$$e_1'' + f_1'' + g_1'' + h_1'' + i_1'' = Bv_1''.$$

Low Grades Sawed From Top Logs of Immature Trees.

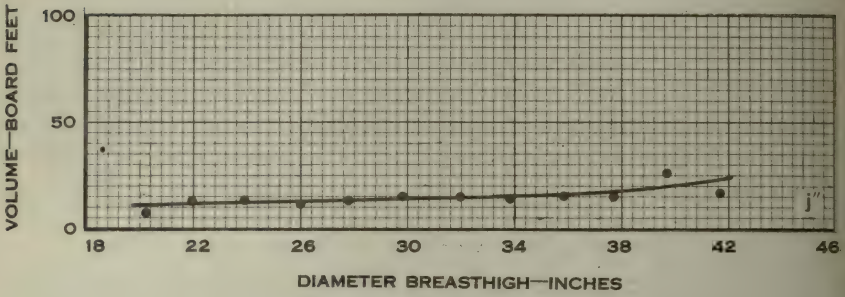


FIG. 171.—Box 1″.

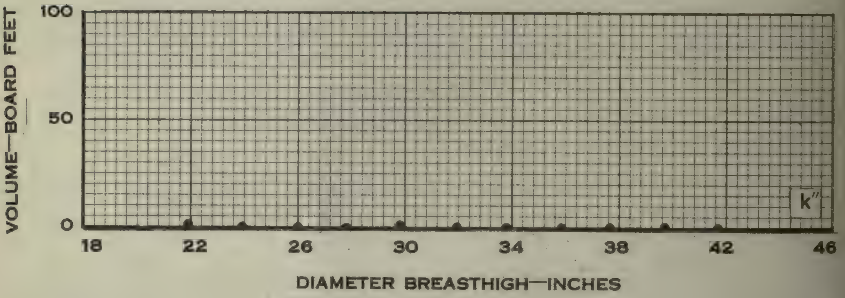


FIG. 172.—Culls.

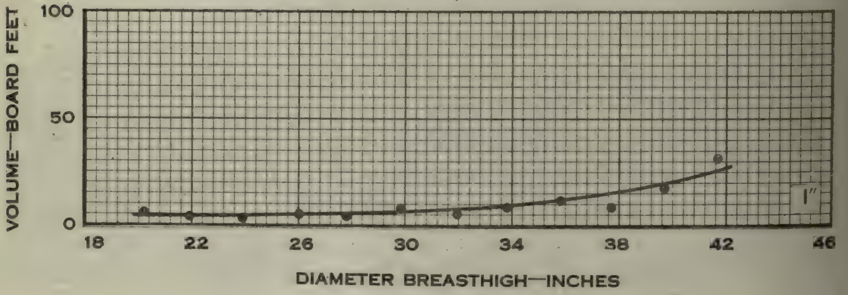


FIG. 173.—Box, 6/4″.

Low Grades Sawed From Top Logs of Mature Trees.

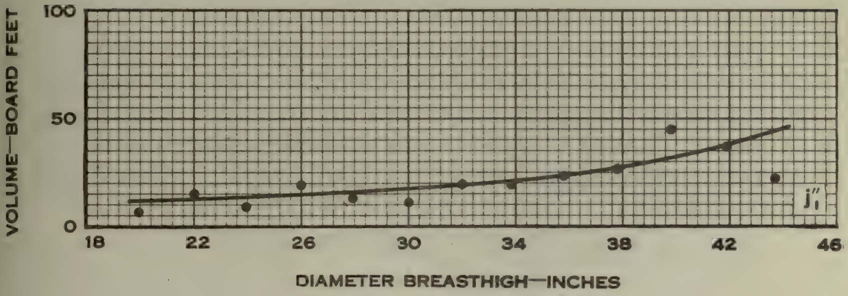


FIG. 174.—Box 1″.

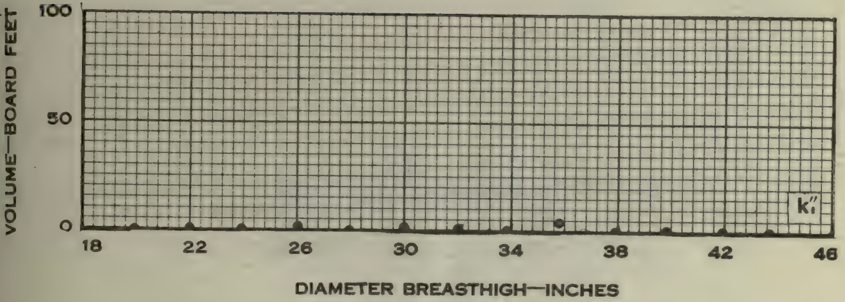


FIG. 175.—Culls.

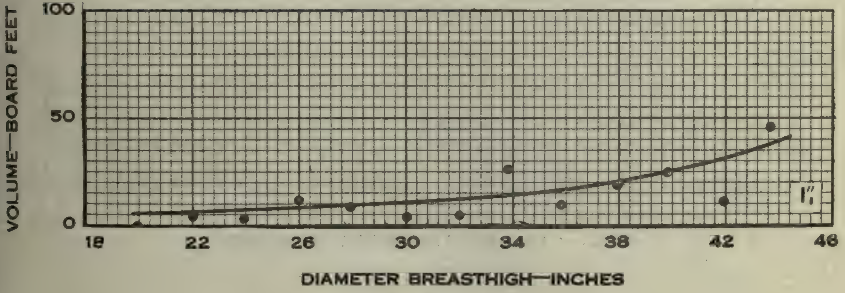


FIG. 176.—Box, 6/4″.

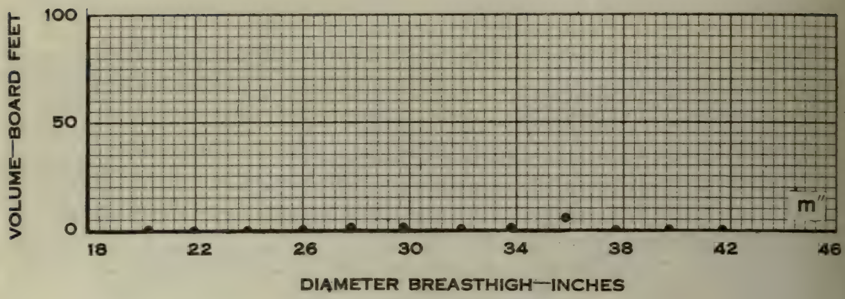


FIG. 177.—No. 3 Shop, 6/4″.

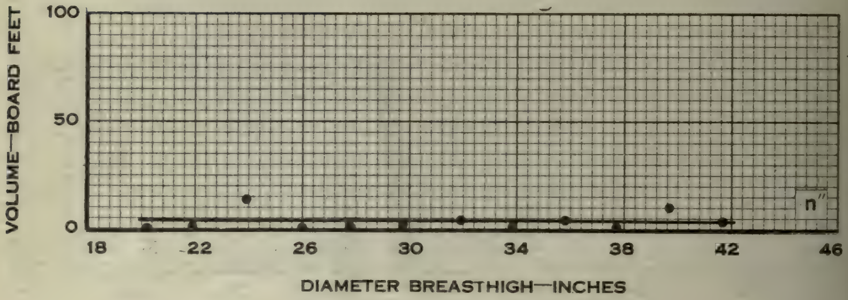


FIG. 178.—No. 3 Common, 1″.

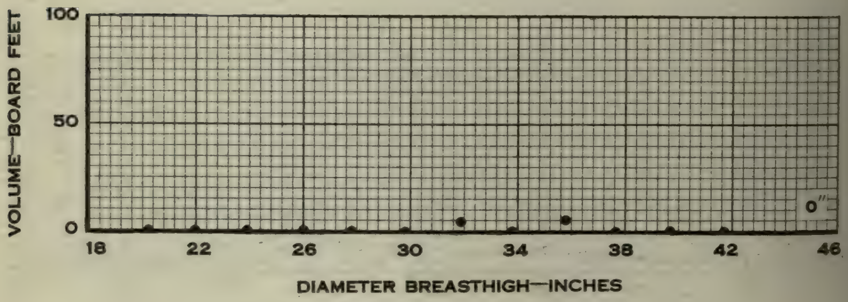


FIG. 179.—Plank, 3″.

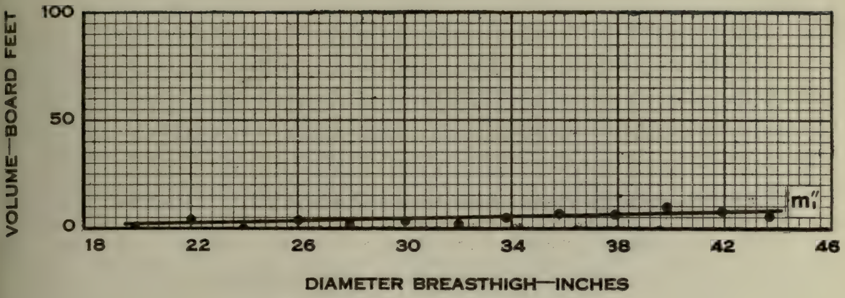


FIG. 180.—No. 3 Shop, 6/4″.

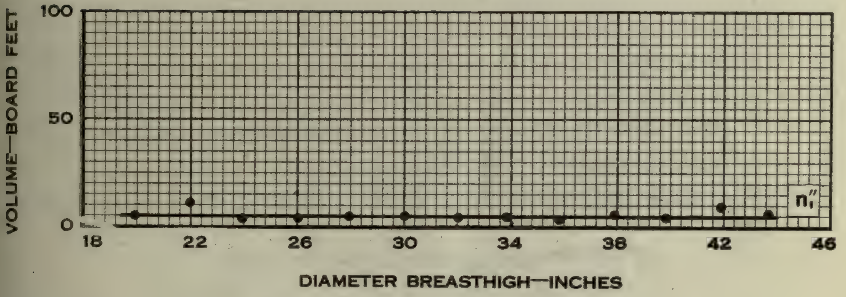


FIG. 181.—No. 3 Common, 1″.

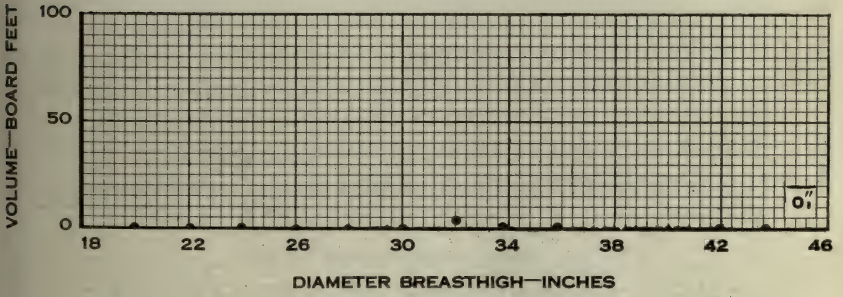


FIG. 182.—Plank, 3″.

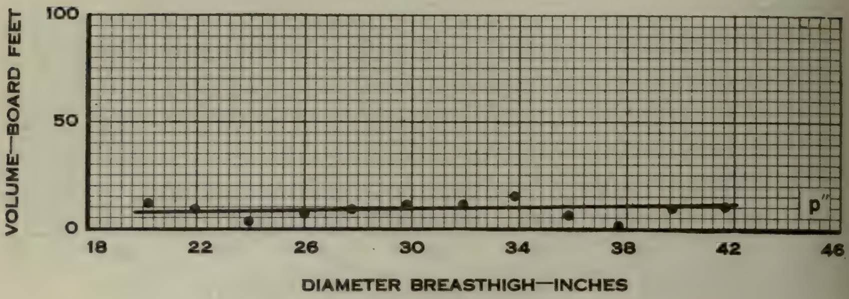


FIG. 183.—4″ x 4″ and Larger.

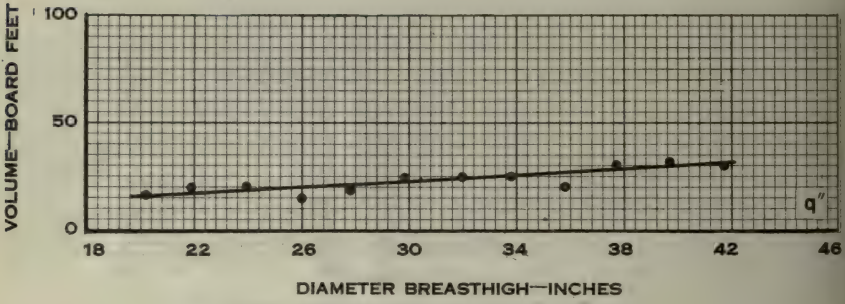


FIG. 184.—2″ x 4″ and Wider, No. 1 Dim.

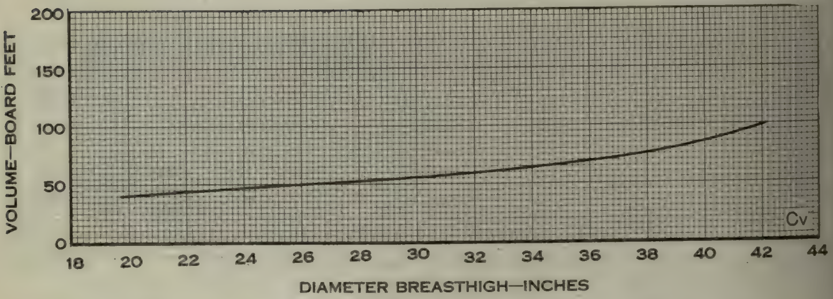


FIG. 185.—Total of low grades sawed from top logs of immature trees.

$$j'' + k'' + l'' + m'' + n'' + o'' + p'' + q'' = Cv''.$$

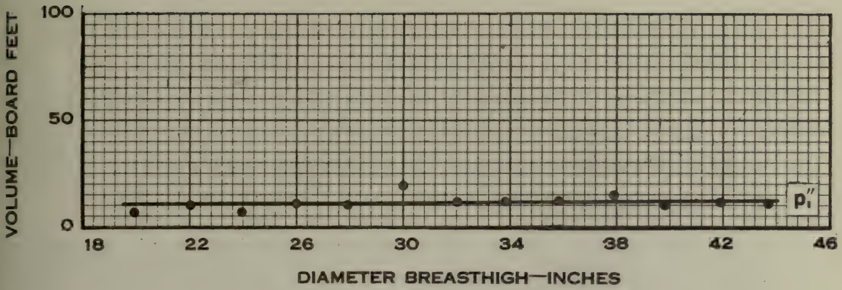


FIG. 186.—4″ x 4″ and Larger.

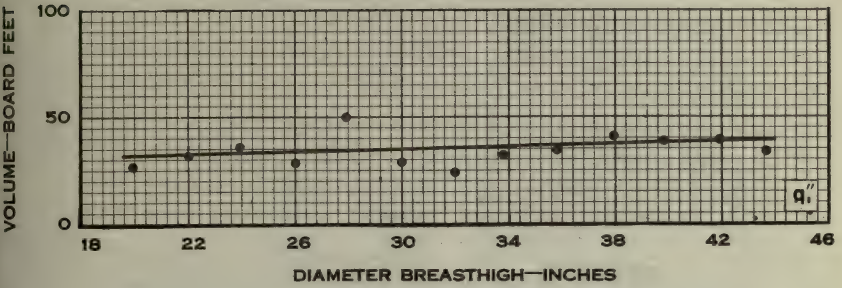


FIG. 187.—2″ x 4″ and Wider, No. 1 Dim.

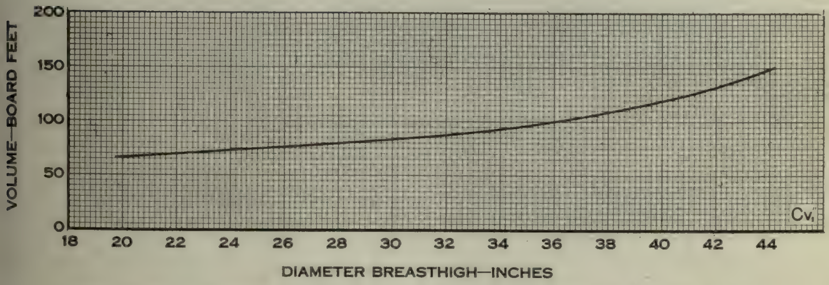


FIG. 188.—Total of low grades sawed from top logs of mature trees.

$$j_1'' + k_1'' + l_1'' + m_1'' + n_1'' + o_1'' + p_1'' + q_1'' = Cv_1''.$$

Value.

Value of Grades Sawed From Top Logs of Immature Trees of Different Diameters Breasthigh, Expressed in Dollars and Cents.

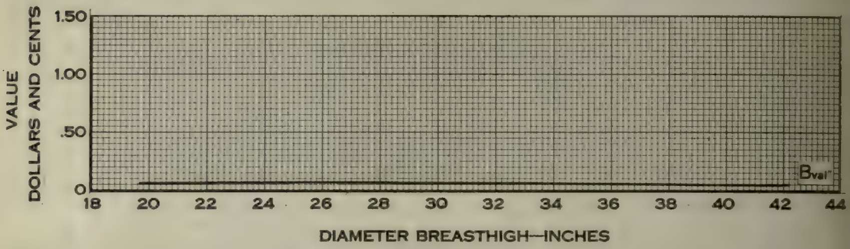


FIG. 189.—Intermediate grades.

$$.022e'' + .018f'' + .018g'' + .018h'' + .007i'' = Bval''.$$

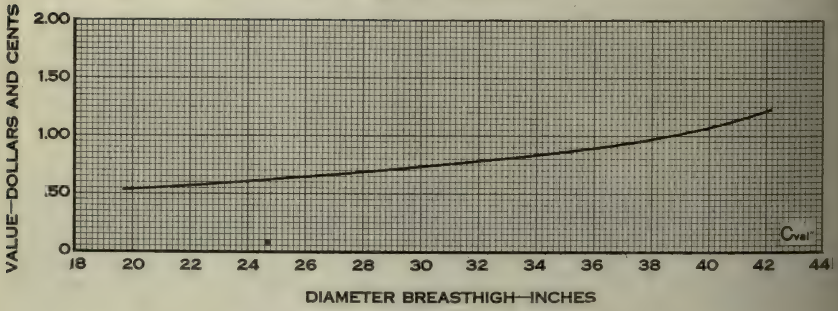


FIG. 190.—Low grades.

$$.009j'' + .007k'' + \_\_\_\_\_\_\_ .015q'' = Cval''.$$

$$Aval'' + Bval'' + Cval'' = B'' = \text{Value per top log.}$$

Value of Grades Sawed From Top Logs of Mature Trees of Different Diameters Breasthigh, Expressed in Dollars and Cents.

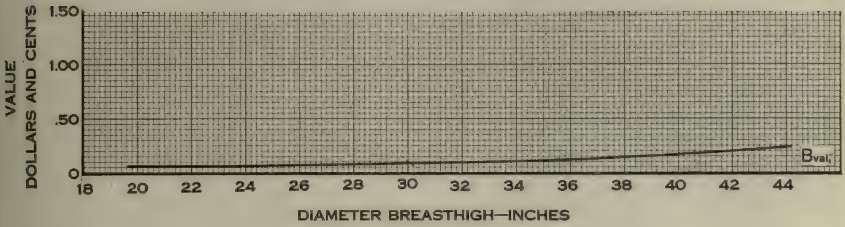


FIG. 191.—Intermediate grades.

$$.022e_1'' + .018f_1'' + .018g_1'' + .018h_1'' + .007i_1'' = Bval_1''.$$

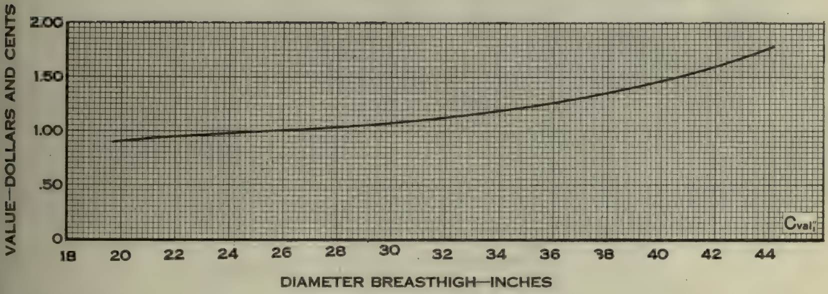


FIG. 192.—Low grades.

$$.009j_1'' + .007k_1'' + \text{-------} .015q_1'' = Cval_1''.$$

$$Aval_1'' + Bval_1'' + Cval_1'' = B_1'' = \text{Value per top log.}$$

A Comparison of Quality of Top Logs, Whole Trees, and Butt Logs.

Diagrams showing the high, intermediate, and low grades, sawed from top logs, whole trees, and butt logs, of immature trees of different diameters breasthigh, expressed in per cent of total sawed out.

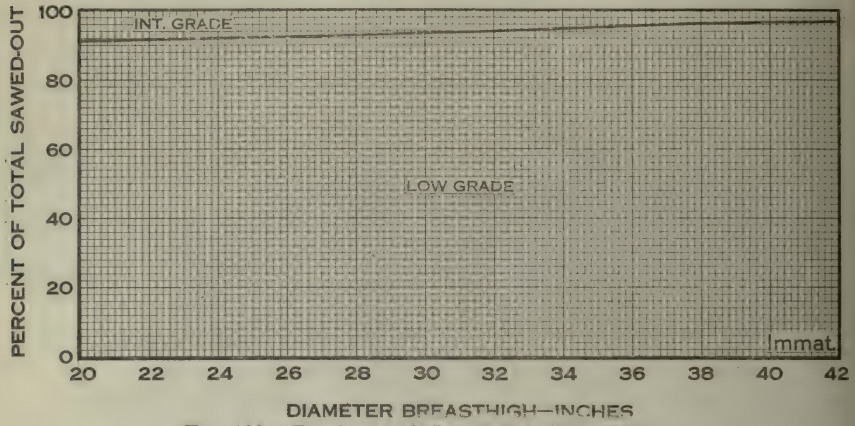


FIG. 193.—Top logs. $Ap'' + Bp'' + Cp'' = 100\%$.

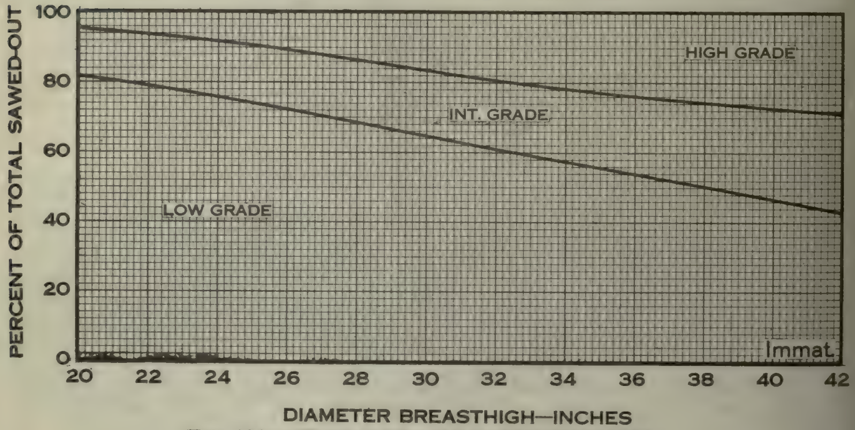
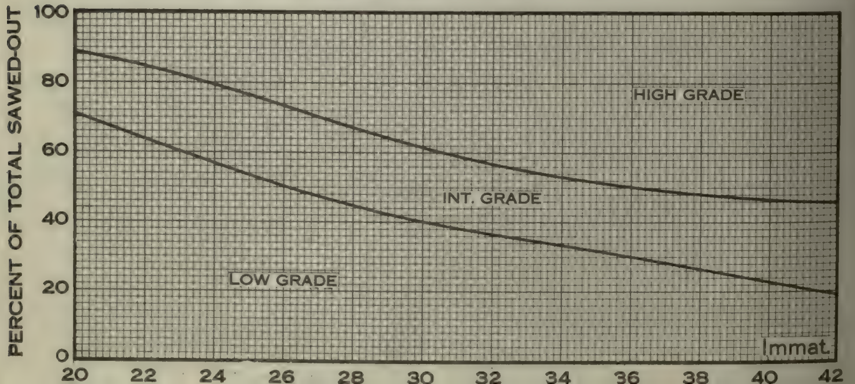


FIG. 194.—Whole trees. $Ap + Bp + Cp = 100\%$.



Diagrams showing the high, intermediate, and low grades, sawed from top logs, whole trees, and butt logs, of mature trees of different diameters breasthigh, expressed in per cent of total sawed out.

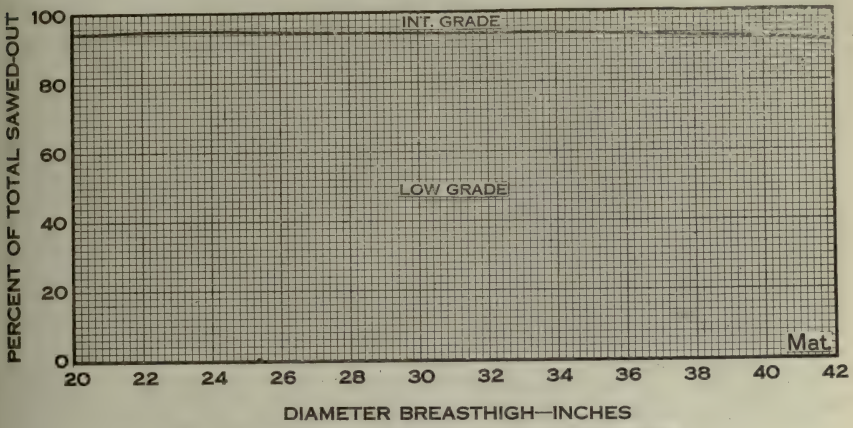


FIG. 196.—Top logs. $Ap_1'' + Bp_1'' + Cp_1'' = 100\%$.

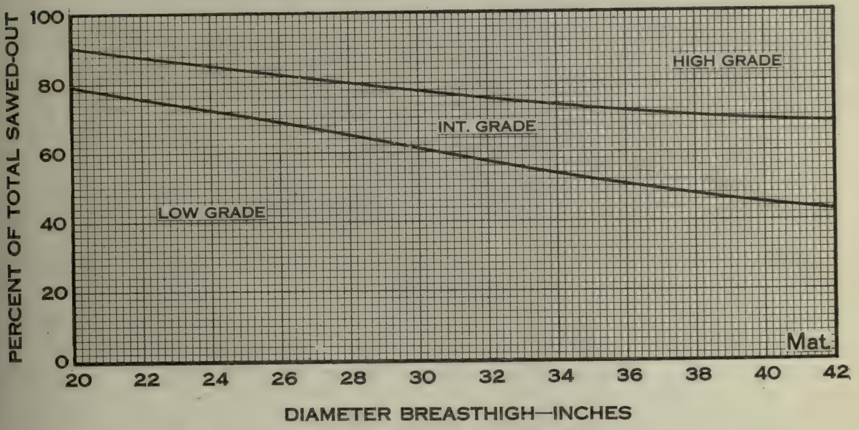
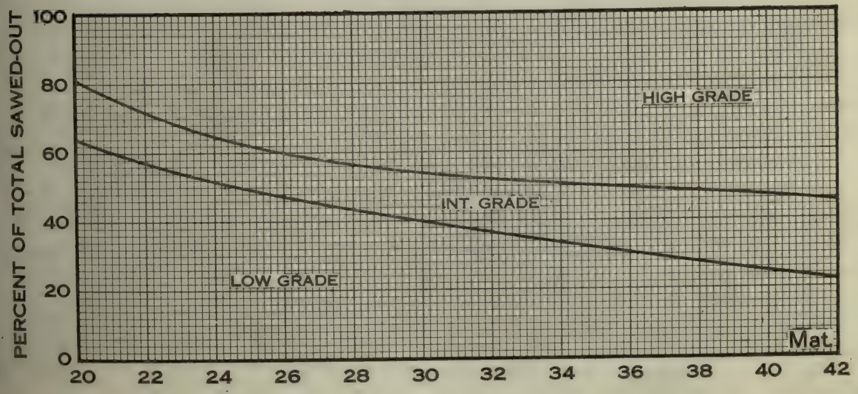


FIG. 197.—Whole trees. $Ap_1 + Bp_1 + Cp_1 = 100\%$.



MILL OVER-RUN.

"Mill over-run" is the difference between the total sawed out volume in board feet and the volume in board feet as indicated by a given log rule, when the former is greater than the latter. Should the total sawed out volume be less than the volume indicated by the log rule, the difference would then be called a "mill under-run."

It is usually customary to express a mill over-run, or under-run, in per cent of volume as indicated by the log rule used. For example: If a log scales 800 board feet and saws out 1000 board feet, the mill over-run is 25%. If it scales 1000 board feet and saws out 800 board feet, the under-run is 20%. If it scales 800 and saws out 800, then it is said to "hold up the scale"; over-run in this case being 0%.

The Spaulding Log Rule, which is the statute rule of California, was used by the Red River Lumber Company in Lassen County, where the field work of this study was conducted, and the following comparisons of total sawed out and log scale are based upon volume indicated by that rule.

In Fig. 199 the average volume in board feet, sawed out at the mill from immature trees of different diameters breasthigh, is shown by Curve A; the average volume for the same trees, as indicated by the Spaulding Log Rule, is shown by Curve As, and the difference between these average curves, which is Curve O, is the average mill over-run from immature trees of different sizes. $(A - As = O)$.

Fig. 200 shows the mill over-run as indicated by Curve O, expressed in per cent of volume in board feet; that is,

$$\frac{100(A - As)}{As} = \frac{100\ O}{As} = Op = \%\ \text{Mill over-run.}$$

Figs. 201 and 202 show similar determinations made for mature yellow pine.

It will be observed that the per cent mill over-run for both immature and mature trees is exceedingly high, and that it is higher for the immature than for the mature, and higher for small trees than for large ones. In Figs. 204 and 206 the same general tendencies will be seen along with the striking feature that these determinations run lower than the ones for whole trees.

These differences are brought about by the log rule used and by local practices in vogue at the mill.

The Spaulding Log Rule, to begin with, has an enormous waste allowance for small logs, which is over 130% of the volume allowed for manufactured product. This allowance becomes smaller as the size of the log in question becomes larger, and approaches 36.5% for very large logs. Such a waste allowance is too large for small logs, even in cases where 36.5% for large logs is about right.

The wastage from small logs should, however, be greater than for large ones, but not three or four times as great, as the Spaulding Log Rule allows. This is why the per cent of mill over-run shown in Figs. 199, 200, 204, and 206 is greater for small diameters than for large ones. It also explains why the per cent over-run for whole trees is much greater than for 16′ but logs from the same trees. The smaller the log the greater the per cent over-run; therefore, a tree 20″ in diameter breasthigh which contains four logs in the merchantable length, three of which are of course smaller than the butt log, has, as a whole, a larger per cent over-run than does the butt log alone. Mature trees and butt logs from them show a lower per cent over-run than do immature trees and butt logs from immature trees of corresponding diameters. The fact that the Spaulding Log Rule is not a level one is also indirectly the cause of this. Mature trees have a thinner bark than the immature, therefore a 16′ butt log from a mature tree of a given diameter breasthigh has a greater diameter inside the bark than a butt log of the same length coming from an immature tree of the same diameter breasthigh. The larger the logs the lower the per cent over-run; hence, the difference between Figs. 204 and 206.

The differences in Figs. 200 and 202 are brought about by thickness of bark together with form of bole. Mature trees show a higher form factor than the immature; they are filled out more, the taper being very slight in the first three or four 16′ logs. The effect of high form factors, or fullness of bole, tends to decrease the per cent of mill over-run.

In Fig. 207 a comparison of per cent over-run for butt logs and whole trees, of immature western yellow pine, is shown, while in Fig. 208 a similar comparison is made for mature trees and 16′ butt logs from them. It will be observed that there is at least 23% over-run in all cases, regardless of size of log or tree. This difference between actual cut at the mill and the Spaulding Log Rule is easily accounted for, since the Spaulding rule was constructed for a thick saw, and since some of the lumber sawed was cut shy on dimensions, and that clear, straight grained edgings were usually graded as moulding stock.

NOTE.—During the season of 1915 it was learned that the company had discontinued the practice of cutting shy on dimensions.

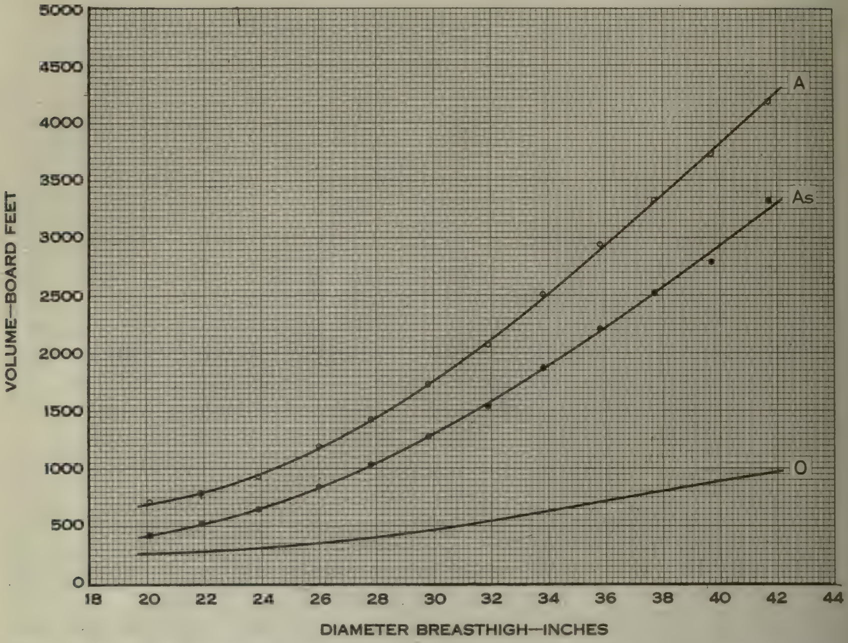


FIG. 199.—Curves showing "mill over-run" for immature trees of different diameters breasthigh. A = Volume in board feet actually sawed out at mill. As = Volume in board feet as shown by the Spaulding Log Rule. O = "Mill over-run" = A — As.

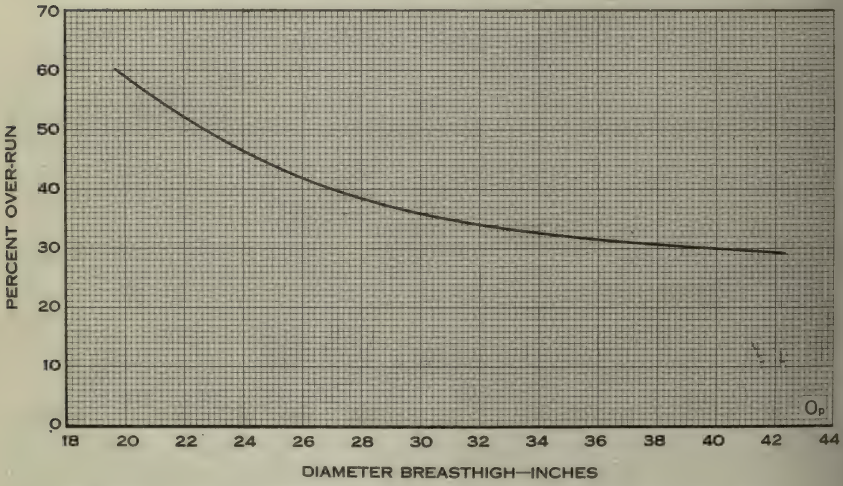


FIG. 200.—Curve showing per cent of "mill over-run" for immature trees.

$$\frac{100\,(A - As)}{As} = \frac{100\,O}{As} = Op.$$

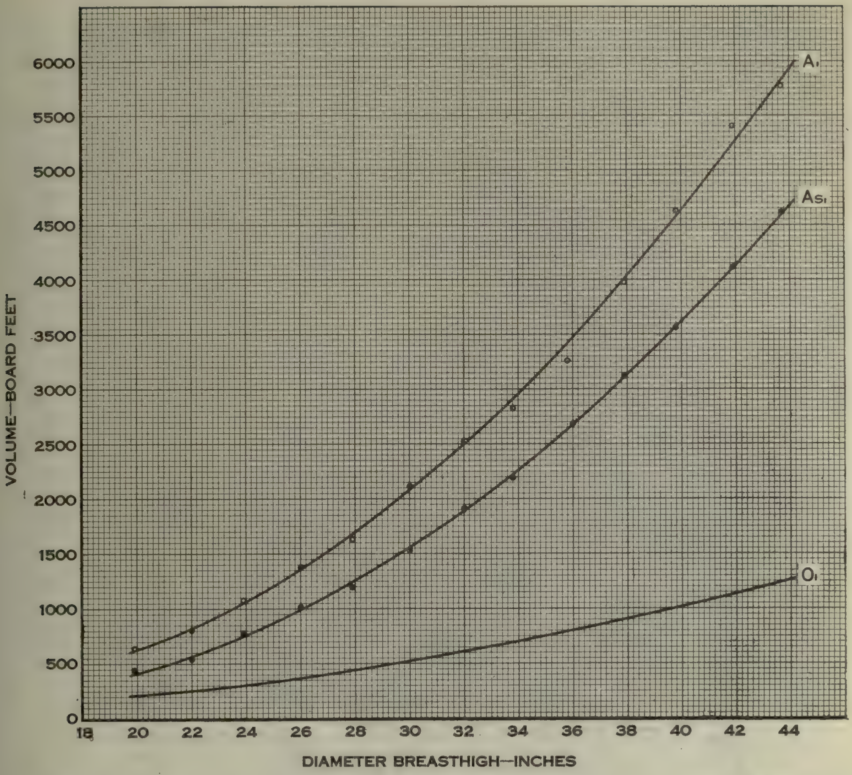


FIG. 201.—Curves showing "mill over-run" for mature trees of different diameters breasthigh. A_1 = Volume in board feet actually sawed out at mill. As_1 = Volume in board feet as shown by the Spaulding Log Rule. O_1 = "Mill over-run" = $A_1 - As_1$.

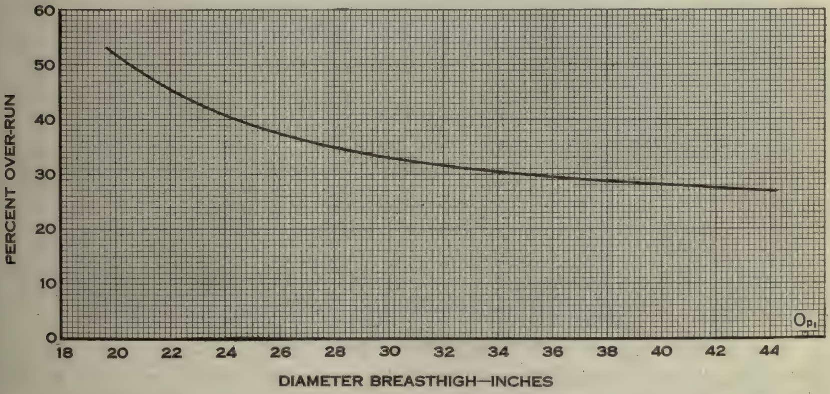


FIG. 202.—Curve showing per cent of "mill over-run" for mature trees.

$$\frac{100\,(A_1 - As_1)}{As_1} = \frac{100\,O_1}{As_1} = Op_1.$$

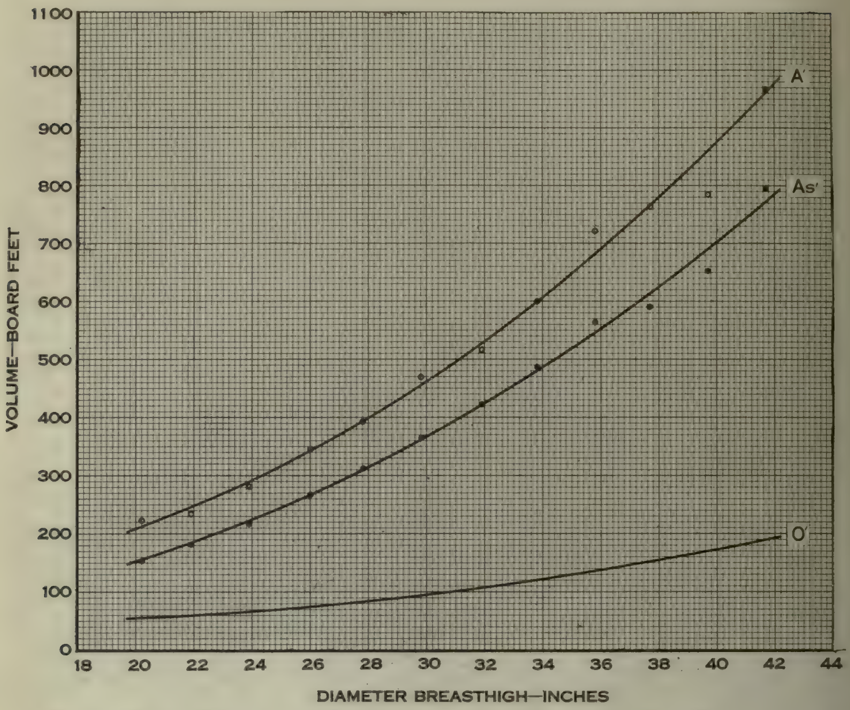


FIG. 203.—Curves showing "mill over-run" for butt logs from immature trees of different diameters breasthigh. A′ = Volume in board feet actually sawed out at mill. As′ = Volume in board feet as shown by the Spaulding Log Rule. O′ = "Mill over-run" = A′ — As′.

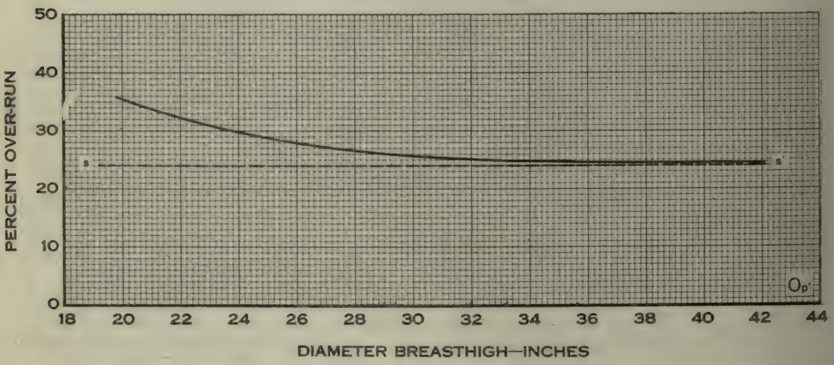


FIG. 204.—Curves showing per cent of "mill over-run" for butt logs from immature trees.

$$\frac{100\ (A' - As')}{As'} = \frac{100\ O'}{As'} = Op'.$$

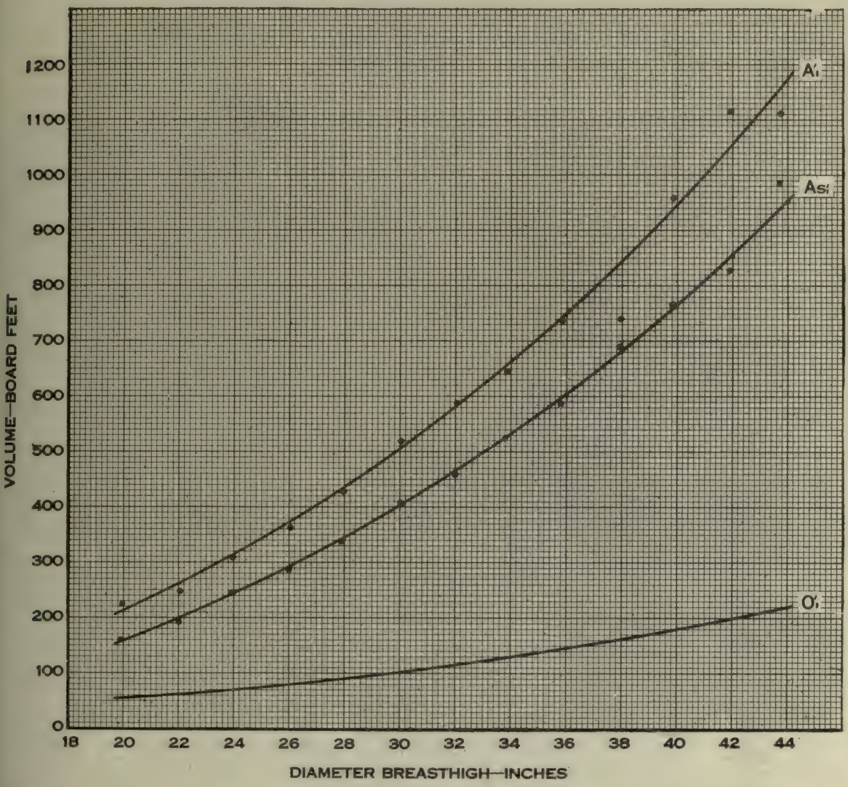


FIG. 205.—Curves showing "mill over-run" for butt logs from mature trees of different diameters breasthigh. $A_1' =$ Volume in board feet actually sawed out at mill. $As_1' =$ Volume in board feet as shown by the Spaulding Log Rule. $O_1' =$ "Mill over-run" $= A_1' - As_1'$.

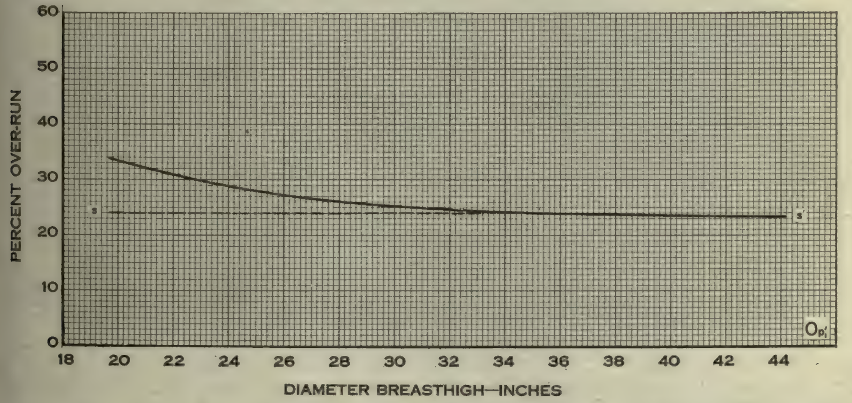


FIG. 206.—Curves showing per cent of "Mill over-run" for butt logs from mature trees.

$$\frac{100\,(A_1' - As_1')}{As_1'} = \frac{100\,O_1'}{As_1'} = Op_1'.$$

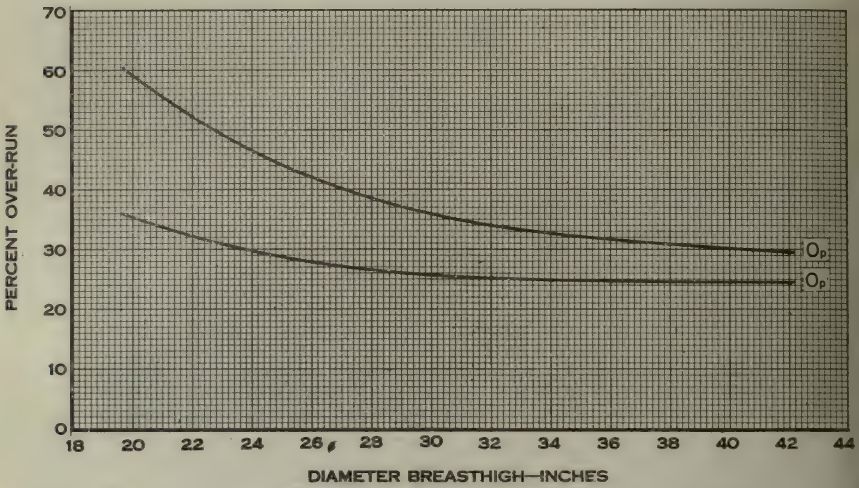


FIG. 207.—A comparison of per cent "over-run" for butt logs and whole trees, of immature western yellow pine.

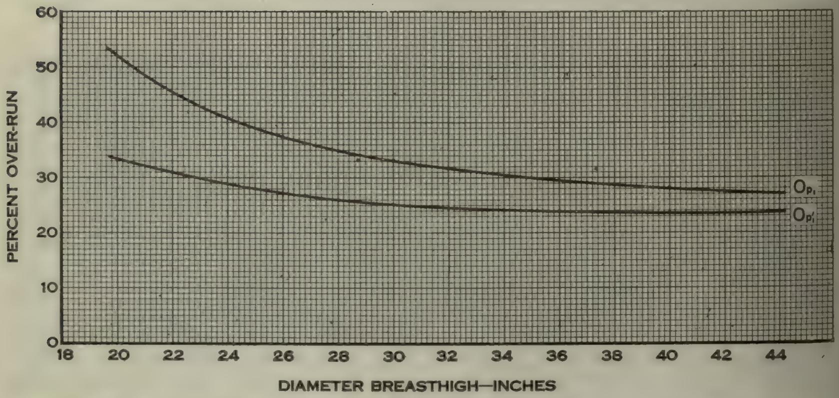


FIG. 208.—A comparison of per cent "over-run" for butt logs and whole trees, of mature western yellow pine.

PART III. TABULATED RESULTS.

AVERAGE VALUES FOR WHOLE TREES.

TABLE 1.—*Age and dimensions.*

(Values read from curves shown in Figs. 4, 5 and 80.)

Diameter breast-high in inches	IMMATURE					MATURE				
	Clear length in feet	Merch. length in feet	Total height in feet	Age in years	D. I. B. top log in inches	Clear length in feet	Merch. length in feet	Total height in feet	Age in years	D. I. B. top log in inches
20	24	84	102	195	6.7	25	84	96	270	7.2
21	24	87	104	200	6.7	26	87	100	280	7.3
22	24	89	107	200	6.8	27	91	104	285	7.5
23	24	91	109	205	6.8	28	94	107	290	7.7
24	24	94	111	205	6.9	29	97	110	295	7.9
25	24	96	113	210	7.0	29	100	113	305	8.1
26	24	99	115	215	7.0	30	103	116	310	8.3
27	25	101	118	215	7.2	30	105	118	315	8.5
28	25	104	120	220	7.2	31	107	121	325	8.7
29	25	106	122	225	7.3	31	110	123	330	8.9
30	25	108	124	225	7.3	32	112	125	335	9.1
31	25	110	126	230	7.4	32	114	128	345	9.3
32	25	112	128	235	7.5	33	117	130	350	9.6
33	25	115	130	240	7.7	33	119	132	360	9.8
34	25	117	132	245	7.7	34	121	134	365	10.0
35	26	119	133	250	7.8	34	123	136	375	10.2
36	26	121	135	255	7.9	34	125	138	380	10.5
37	26	123	137	260	8.2	35	127	139	390	10.7
38	26	125	139	270	8.6	35	129	141	395	11.0
39	26	127	141	275	9.0	35	131	143	405	11.2
40	26	129	142	285	9.6	36	133	145	410	11.5
41	26	131	143	295	10.3	36	135	147	420	11.8
42	26	133	145	305	11.2	36	137	148	430	12.1
43	---------	---------	---------	---------	---------	37	138	150	435	12.3
44	---------	---------	---------	---------	---------	37	141	152	445	12.7

TABLE 2.—*Form factors for merchantable portion of western yellow pine trees of different diameters breasthigh.*

$$\text{Form factor} = \frac{\text{Vol. cu. ft. inside bark contained in merch. lgth.}}{.7854 \div 144\ (\text{D.B.H.})^2 \times \text{merch. lgth. in feet}}$$

Diameter breasthigh in inches	IMMATURE			MATURE		
	Merch. volume in cubic feet	Volume of cylinder in cubic feet	Form factor	Merch. volume in cubic feet	Volume of cylinder in cubic feet	Form factor
20	80	183	.437	83	183	.453
22	98	235	.417	106	240	.442
24	119	295	.404	133	304	.437
26	143	364	.395	165	379	.436
28	173	443	.391	200	457	.438
30	207	529	.391	241	548	.439
32	244	625	.391	288	653	.442
34	287	737	.390	339	761	.445
36	333	854	.390	395	882	.448
38	384	984	.390	457	1013	.450
40	437	1122	.389	523	1159	.451
42	497	1278	.389	595	1315	.453
44	---------	---------	---------	667	1450	.459

TABLE 3.—*Average volume in board feet of each grade actually "sawed out" at mill, from merchantable portion of immature western yellow pine trees of different diameters breasthigh.*

(Values read from curves shown on left-hand pages, Nos. 40 to 54, inclusive.)

Diameter breasthigh in inches	HIGH GRADES					INTERMEDIATE GRADES						LOW GRADES									Total sawed out, all grades
	C. & Bet. 6/4	Mldg. Stock	No. 1 Shop 6/4	D. Sel. & Bet. 1"	Total	No. 1 Com. 1"	No. 2 Com. 1"	Shop 1"	No. 2 Shop 6/4	Shims	Total	Box 1"	Cull 2"	Box 6/4	No. 3 Shop 6/4	No. 3 Com. 1"	Plank 3"	4x4 & Lgr.	2x4 & wider No. 1 Dim.	Total	
	a +	b +	c +	d =	Av.	e +	f +	g +	h +	i =	Bv.	j +	k +	l +	m +	n +	o +	p +	q =	Cv.	A
20	0	15	4	10	29	30	35	8	14	8	95	60	5	90	45	25	8	118	210	561	685
21	5	17	5	12	39	29	37	10	19	10	105	64	5	96	49	26	12	122	216	590	734
22	8	19	6	15	48	28	40	12	25	12	117	68	5	103	58	27	16	126	222	625	790
23	13	22	10	17	62	28	43	15	34	15	135	72	6	110	67	28	21	134	236	674	871
24	18	25	15	20	78	27	45	19	46	16	153	76	7	114	80	30	26	142	250	725	956
25	23	28	24	23	98	27	47	20	61	18	173	80	8	120	92	31	30	158	267	783	1057
26	32	32	35	26	125	26	50	22	78	20	196	84	8	128	106	33	35	175	285	854	1175
27	44	36	51	29	160	26	53	25	99	22	225	87	8	134	120	35	37	194	305	920	1305
28	60	40	70	32	202	25	55	28	122	25	255	90	8	140	135	36	40	214	325	988	1445
29	75	44	88	36	243	25	58	34	147	28	292	93	8	146	154	37	43	236	346	1063	1598
30	95	48	109	41	293	24	60	40	174	32	330	95	7	149	171	39	45	259	367	1133	1756
31	118	52	132	46	348	23	63	46	202	37	371	98	7	158	190	41	50	281	390	1215	1934
32	145	57	158	52	412	22	65	54	233	42	416	101	7	161	210	42	54	303	413	1291	2119
33	170	63	185	56	474	22	68	66	267	48	471	103	7	168	228	43	56	317	447	1369	2314
34	200	70	215	61	546	21	70	80	304	54	529	106	7	172	248	45	59	332	482	1451	2526
35	231	76	247	66	620	21	72	93	344	61	594	108	12	178	264	48	61	346	512	1529	2743
36	266	83	282	72	703	21	75	114	384	68	662	110	18	181	280	50	63	351	542	1595	2960
37	300	88	317	77	782	21	79	136	426	76	738	112	25	187	292	55	64	375	545	1655	3175
38	338	94	353	82	858	21	84	160	468	85	818	115	33	189	303	60	66	400	535	1701	3387
39	372	101	390	88	951	21	91	186	511	95	904	117	42	192	312	66	68	435	510	1742	3597
40	413	108	428	94	1043	21	98	215	555	106	995	120	51	193	323	72	70	470	485	1787	3825
41	452	115	466	99	1132	21	111	248	600	121	1101	122	63	198	330	81	71	508	435	1808	4041
42	495	122	505	104	1226	21	115	282	645	135	1198	124	75	202	340	90	73	547	385	1836	4260

TABLE 4.—*Average volume in board feet of each grade actually "sawed out" at mill, from merchantable portion of mature western yellow pine trees of different diameters breasthigh.*

(Values read from curves shown on right-hand pages, Nos. 41 to 55, inclusive.)

Diameter breasthigh in inches	HIGH GRADES					INTERMEDIATE GRADES						LOW GRADES									Total sawed out, all grades
	C. & Bet. 6/4	Mldg. Stock	No. 1 Shop 6/4	D. Sel. & Bet. 1"	Total	No. 1 Com. 1"	No. 2 Com. 1"	Shop 1"	No. 2 Shop 6/4	Shims	Total	Box 1"	Cull 2"	Box 6/4	No. 3 Shop 6/4	No. 3 Com. 1"	Plank 3"	4x4 & Lgr.	2x4 & wider No. 1 Dim.	Total	
	a_1 +	b_1 +	c_1 +	d_1	= Av_1	e_1 +	f_1 +	g_1 +	h_1 +	i_1	= Bv_1	j_1 +	k_1 +	l_1 +	m_1 +	n_1 +	o_1 +	p_1 +	q_1	= Cv_1	A_1
20	0	24	12	22	58	12	30	12	7	8	69	52	9	92	42	32	8	70	195	500	627
21	0	28	13	26	67	12	31	14	12	9	78	55	9	100	50	34	12	90	208	558	703
22	27	32	17	32	108	12	32	16	22	10	92	60	9	105	58	35	20	112	220	619	819
23	36	36	22	36	130	12	34	18	34	12	110	65	10	115	68	35	25	140	234	692	932
24	52	40	30	40	162	12	35	21	48	14	130	70	10	122	80	36	31	172	250	771	1063
25	67	44	40	43	194	12	36	24	68	16	156	75	11	130	94	37	36	205	268	856	1206
26	86	49	52	48	235	12	37	30	88	18	185	80	11	138	108	38	42	236	285	938	1358
27	108	53	70	54	285	12	38	35	115	20	220	85	12	145	125	40	48	265	308	1028	1533
28	130	58	92	58	338	12	40	42	142	22	258	90	12	154	140	41	52	292	328	1109	1705
29	152	62	120	62	396	12	41	52	172	24	301	95	12	160	155	41	59	318	350	1190	1887
30	176	68	150	68	462	11	42	62	208	26	349	100	13	168	174	42	64	340	375	1276	2087
31	206	74	185	72	537	11	43	74	245	28	401	105	13	174	192	42	69	364	400	1359	2297
32	234	80	222	76	612	11	44	86	280	30	451	110	14	180	212	44	74	382	426	1442	2505
33	265	86	263	81	695	11	46	106	320	33	516	115	14	188	232	45	78	400	454	1526	2737
34	295	93	305	88	781	11	48	128	360	36	583	120	15	194	252	48	82	418	480	1609	2973
35	330	100	350	92	872	11	52	150	408	40	661	125	15	200	272	52	84	430	510	1688	3221
36	365	108	404	100	977	11	54	180	455	44	744	128	16	205	292	56	87	440	540	1764	3485
37	400	115	460	106	1081	11	56	210	505	48	830	134	19	212	312	60	91	448	570	1846	3757
38	440	124	515	112	1191	10	60	240	555	52	917	138	21	218	335	63	93	452	604	1924	4032
39	475	132	572	120	1299	10	62	274	610	56	1012	142	24	222	360	70	96	454	639	2007	4318
40	515	142	640	128	1425	10	65	315	668	62	1120	147	28	228	382	78	100	450	672	2085	4630
41	555	153	702	135	1545	10	70	350	725	71	1226	152	34	234	405	88	103	445	706	2167	4938
42	600	165	770	144	1679	10	75	396	780	79	1340	157	42	240	430	100	106	436	745	2256	5275
43	640	180	840	152	1812	10	80	440	844	88	1462	162	53	244	452	112	109	415	782	2329	5603
44	680	195	912	161	1948	10	86	485	905	100	1586	167	62	250	474	130	112	386	820	2401	5935

TABLE 5.—*Grades sawed from immature trees of different diameters breasthigh, expressed in per cent of total sawed out.*

(Values in this table obtained as indicated by $\frac{100a}{A}+\frac{100b}{A}+$ etc. Curves Ap, Bp and Cp shown in Figs. 54, 55 and 56.)

Diameter breasthigh in inches	HIGH GRADES					INTERMEDIATE GRADES						LOW GRADES									Total sawed out, all grades
	C. & Bet. 6/4	Mldg. Stock	No. 1 Shop 6/4	D. Sel. & Bet. 1″	Total	No. 1 Com. 1″	No. 2 Com. 1″	Shop 1″	No. 2 Shop 6/4	Shims	Total	Box 1″	Cull 2″	Box 6/4	No.3 Shop 6/4	No. 3 Com. 1″	Plank 3″	4x4 & Lgr.	2x4 & wider No. 1 Dim.	Total	
	$\frac{100a}{A}+$	$\frac{100b}{A}+$	$\frac{100c}{A}+$	$\frac{100d}{A}=$	Ap	$\frac{100e}{A}+$	$\frac{100f}{A}+$	$\frac{100g}{A}+$	$\frac{100h}{A}+$	$\frac{100i}{A}=$	Bp	$\frac{100j}{A}+$	$\frac{100k}{A}+$	$\frac{100l}{A}+$	$\frac{100m}{A}+$	$\frac{100n}{A}+$	$\frac{100o}{A}+$	$\frac{100p}{A}+$	$\frac{100q}{A}=$	Cp	A
20	0.0	2.1	0.6	1.5	4.2	4.4	5.1	1.1	2.1	1.1	13.8	8.8	0.7	13.2	6.6	3.7	1.1	17.2	30.7	82.0	685
21	0.7	2.3	0.7	1.6	5.3	4.0	5.0	1.4	2.6	1.4	14.4	8.7	0.7	13.1	6.7	3.5	1.6	16.6	29.4	80.3	734
22	0.9	2.5	0.8	1.9	6.1	3.5	5.1	1.5	3.2	1.5	14.8	8.6	0.7	13.0	7.3	3.4	2.0	16.0	28.1	79.1	790
23	1.5	2.6	1.1	2.0	7.2	3.2	4.9	1.7	3.9	1.7	15.4	8.3	0.7	12.6	7.7	3.2	2.4	15.4	27.1	77.4	871
24	1.9	2.6	1.6	2.1	8.2	2.8	4.7	2.0	4.8	1.7	16.0	7.9	0.7	11.9	8.4	3.1	2.7	14.9	26.2	75.8	956
25	2.2	2.6	2.3	2.2	9.3	2.6	4.5	1.9	5.8	1.7	16.5	7.6	0.8	11.3	8.6	2.9	2.8	14.9	25.3	74.2	1057
26	2.7	2.7	2.9	2.2	10.5	2.2	4.3	1.9	6.6	1.7	16.7	7.2	0.7	10.9	9.0	2.8	3.0	14.9	24.3	72.8	1175
27	3.4	2.8	3.9	2.2	12.3	2.0	4.1	1.9	7.6	1.7	17.3	6.7	0.6	10.3	9.2	2.7	2.8	14.8	23.3	70.4	1305
28	4.2	2.7	4.8	2.2	13.9	2.2	3.8	1.8	8.4	1.7	17.9	6.2	0.5	9.7	9.5	2.4	2.8	14.8	22.5	68.2	1445
29	4.7	2.8	5.5	2.3	15.3	1.6	3.6	2.1	9.2	1.8	18.3	5.8	0.5	9.1	9.6	2.3	2.7	14.8	21.6	66.4	1598
30	5.4	2.7	6.2	2.3	16.6	1.4	3.4	2.3	9.9	1.8	18.8	5.4	0.4	8.5	9.8	2.2	2.6	14.8	20.9	64.6	1756
31	6.1	2.7	6.8	2.4	18.0	1.2	3.3	2.4	10.4	1.9	19.2	5.1	0.4	8.2	9.8	2.1	2.5	14.6	20.1	62.8	1934
32	6.8	2.7	7.5	2.4	19.4	1.0	3.1	2.6	11.0	1.9	19.6	4.8	0.3	7.6	10.0	2.0	2.5	14.3	19.5	61.0	2119
33	7.4	2.8	8.0	2.4	20.6	0.9	2.9	2.8	11.5	2.1	20.2	4.5	0.3	7.3	9.9	1.9	2.4	13.6	19.3	59.2	2314
34	7.9	2.8	8.5	2.4	21.6	0.8	2.8	3.2	12.1	2.1	21.0	4.2	0.3	6.8	9.8	1.8	2.3	13.1	19.1	57.4	2526
35	8.4	2.8	9.0	2.4	22.6	0.8	2.6	3.5	12.6	2.2	21.7	4.3	0.4	6.5	9.6	1.8	2.2	12.6	18.3	55.7	2743
36	8.9	2.8	9.5	2.4	23.6	0.7	2.6	3.9	13.0	2.3	22.5	3.7	0.6	6.1	9.5	1.7	2.1	11.9	18.3	53.9	2960
37	9.4	2.8	10.0	2.5	24.7	0.7	2.5	4.3	13.4	2.4	23.3	3.5	0.8	5.9	9.2	1.7	2.0	11.8	17.1	52.0	3175
38	10.0	2.8	10.4	2.4	25.6	0.6	2.5	4.7	13.8	2.5	24.1	3.4	0.9	5.6	9.0	1.8	2.0	11.8	15.8	50.3	3387
39	10.3	2.8	10.9	2.4	26.4	0.6	2.5	5.2	14.2	2.6	25.1	3.3	1.2	5.3	8.7	1.8	1.9	12.1	14.2	48.5	3597
40	10.8	2.8	11.2	2.5	27.3	0.5	2.6	5.6	14.5	2.8	26.0	3.1	1.3	5.1	8.5	1.9	1.8	12.3	12.7	46.7	3825
41	11.2	2.8	11.5	2.4	27.9	0.5	2.7	6.1	14.9	3.0	27.2	3.0	1.6	4.9	8.2	2.0	1.8	12.6	10.8	44.9	4041
42	11.6	2.8	11.9	2.4	28.7	0.5	2.7	6.6	15.2	3.2	28.2	2.9	1.8	4.8	8.0	2.1	1.7	12.8	9.0	43.1	4260

TABLE 6.—*Grades sawed from mature trees of different diameters breasthigh, expressed in per cent of total sawed out.*

(Values in this table obtained as indicated by $\frac{100a_1}{A_1}+\frac{100b_1}{A_1}+$ etc. Curves Ap_1, Bp_1 and Cp_1 shown in Figs. 57, 58 and 59.)

Diameter breasthigh in inches	HIGH GRADES					INTERMEDIATE GRADES						LOW GRADES									Total sawed out, all grades
	C. & Bet. 6/4	Mldg. Stock	No. 1 Shop 6/4	D. Sel. & Bet. 1″	Total	No. 1 Com. 1″	No. 2 Com. 1″	Shop 1″	No. 2 Shop 6/4	Shims	Total	Box 1″	Cull 2″	Box 6/4	No. 3 Shop 6/4	No. 3 Com. 1″	Plank 3″	4x4 & Lgr.	2x4 & wider No. 1 Dim.	Total	
	$\frac{100a_1}{A_1}+$	$\frac{100b_1}{A_1}+$	$\frac{100c_1}{A_1}+$	$\frac{100d_1}{A_1}$	$=Ap_1$	$\frac{100e_1}{A_1}+$	$\frac{100f_1}{A_1}+$	$\frac{100g_1}{A_1}+$	$\frac{100h_1}{A_1}+$	$\frac{100i_1}{A_1}$	$=Bp_1$	$\frac{100j_1}{A_1}+$	$\frac{100k_1}{A_1}+$	$\frac{100l_1}{A_1}+$	$\frac{100m_1}{A_1}+$	$\frac{100n_1}{A_1}+$	$\frac{100o_1}{A_1}+$	$\frac{100p_1}{A_1}+$	$\frac{100q_1}{A_1}$	$=Cp_1$	A_1
20	0.0	3.8	1.9	3.5	9.2	1.9	4.8	1.9	1.1	1.3	11.0	8.3	1.4	14.7	6.7	5.1	1.3	11.2	31.1	79.8	627
21	0.0	4.0	1.9	3.7	9.6	1.7	4.4	2.0	1.7	1.3	11.1	7.8	1.3	14.2	7.1	4.8	1.7	12.8	29.6	79.3	703
22	3.3	3.9	2.1	3.9	13.2	1.5	3.9	2.0	2.7	1.2	11.3	7.3	1.1	12.8	7.1	4.3	2.4	13.7	26.8	75.5	819
23	3.9	3.9	2.4	3.9	14.1	1.3	3.6	1.9	3.6	1.3	11.7	7.0	1.0	12.3	7.3	3.8	2.7	15.0	25.1	74.2	932
24	4.9	3.8	2.8	3.8	15.3	1.1	3.3	2.0	4.5	1.3	12.2	6.6	0.9	11.5	7.5	3.4	2.9	16.2	23.5	72.5	1063
25	5.6	3.6	3.3	3.6	16.1	1.0	3.0	2.0	5.6	1.3	12.9	6.2	0.9	10.8	7.8	3.1	3.0	17.0	22.2	71.0	1206
26	6.3	3.6	3.8	3.5	17.2	0.9	2.7	2.2	6.5	1.3	13.6	5.9	0.8	10.2	8.0	2.8	3.1	17.4	21.0	69.2	1358
27	7.0	3.5	4.6	3.5	18.6	0.8	2.5	2.3	7.5	1.3	14.4	5.5	0.8	9.5	8.1	2.6	3.1	17.3	20.1	67.0	1533
28	7.6	3.4	5.4	3.4	19.8	0.7	2.4	2.5	8.3	1.3	15.2	5.3	0.7	9.0	8.2	2.4	3.1	17.1	19.2	65.0	1705
29	8.1	3.3	6.4	3.3	21.1	0.6	2.2	2.8	9.1	1.3	16.0	5.0	0.6	8.5	8.2	2.2	3.1	16.8	18.5	62.9	1887
30	8.4	3.3	7.2	3.3	22.2	0.5	2.0	3.0	10.0	1.2	16.7	4.8	0.6	8.0	8.3	2.0	3.1	16.3	18.0	61.1	2087
31	9.0	3.2	8.1	3.1	23.4	0.5	1.9	3.2	10.7	1.2	17.5	4.6	0.6	7.5	8.4	1.8	3.0	15.8	17.4	59.1	2297
32	9.3	3.2	8.9	3.0	24.4	0.4	1.8	3.4	11.2	1.2	18.0	4.4	0.5	7.2	8.5	1.8	3.0	15.2	17.0	57.6	2505
33	9.7	3.1	9.6	3.0	25.4	0.4	1.7	3.9	11.7	1.2	18.9	4.2	0.5	6.9	8.5	1.6	2.8	14.6	16.6	55.7	2737
34	9.9	3.1	10.2	3.0	26.2	0.4	1.6	4.3	12.1	1.2	19.6	4.0	0.5	6.6	8.5	1.6	2.8	14.1	16.1	54.2	2973
35	10.2	3.1	10.9	2.9	27.1	0.3	1.6	4.7	12.7	1.2	20.5	3.9	0.5	6.2	8.5	1.6	2.6	13.3	15.8	52.4	3221
36	10.5	3.1	11.6	2.9	28.1	0.3	1.5	5.1	13.1	1.3	21.3	3.6	0.5	5.9	8.4	1.6	2.5	12.6	15.5	50.6	3485
37	10.7	3.1	12.2	2.8	28.8	0.3	1.5	5.6	13.5	1.3	22.2	3.5	0.5	5.6	8.3	1.6	2.4	11.9	15.2	49.0	3757
38	10.9	3.1	12.8	2.8	29.6	0.2	1.5	5.9	13.7	1.3	22.6	3.4	0.5	5.4	8.3	1.6	2.3	11.2	15.1	47.8	4032
39	11.0	3.1	13.3	2.8	30.2	0.2	1.4	6.3	14.2	1.3	23.4	3.3	0.6	5.1	8.3	1.6	2.2	10.5	14.8	46.4	4318
40	11.1	3.1	13.8	2.8	30.8	0.2	1.4	6.8	14.4	1.3	24.1	3.2	0.6	4.9	8.3	1.7	2.2	9.7	14.5	45.1	4630
41	11.2	3.1	14.2	2.8	31.3	0.2	1.4	7.1	14.7	1.4	24.8	3.1	0.7	4.7	8.2	1.8	2.1	9.0	14.3	43.9	4938
42	11.3	3.1	14.6	2.7	31.7	0.2	1.4	7.5	14.8	1.5	25.4	3.0	0.8	4.6	8.2	1.9	2.0	8.3	14.1	42.9	5275
43	11.4	3.2	15.0	2.7	32.3	0.2	1.4	7.9	15.1	1.6	26.2	2.9	0.9	4.4	8.0	2.0	1.9	7.4	14.0	41.5	5603
44	11.5	3.3	15.4	2.7	32.9	0.2	1.4	8.2	15.3	1.7	26.8	2.8	1.0	4.2	8.0	2.2	1.9	6.5	13.7	40.3	5935

TABLE 7.—*Value of grades sawed from immature trees of different diameters breasthigh, expressed in dollars and cents.*

(Values in this table obtained as indicated by $.032a + .030b$ + etc. Curves Aval, Bval and Cval shown in Figs. 62, 63 and 64.)

Diameter breasthigh in inches	HIGH GRADES					INTERMEDIATE GRADES						LOW GRADES									Value per tree
	C. & Bet. 6/4	Mldg. Stock	No. 1 Shop 6/4	D. Sel. & Bet. 1″	Total	No. 1 Com. 1″	No. 2 Com. 1″	Shop 1″	No. 2 Shop 6/4	Shims	Total	Box 1″	Cull 2″	Box 6/4	No. 3 Shop 6/4	No. 3 Com. 1″	Plank 3″	4x4 & Lgr.	2x4 & wider No. 1 Dim.	Total	
	.032a +.030b +.027c +.025d =Aval.					.022e +.018f +.018g +.018h +.007i =Bval.						.009j +.007k +.011l +.013m +.015n +.015o +.015p +.015q =Cval.									B
20	.00	.45	.11	.25	.81	.66	.63	.14	.25	.06	1.74	.54	.04	.99	.58	.37	.12	1.77	3.15	7.56	10.11
21	.16	.51	.14	.30	1.11	.64	.67	.18	.34	.07	1.90	.58	.04	1.06	.64	.39	.18	1.83	3.24	7.96	10.97
22	.26	.57	.16	.38	1.37	.62	.72	.21	.45	.08	2.08	.61	.04	1.13	.75	.40	.24	1.89	3.33	8.39	11.84
23	.42	.66	.27	.43	1.78	.60	.77	.27	.61	.10	2.35	.65	.04	1.21	.87	.42	.31	2.01	3.54	9.05	13.18
24	.58	.75	.41	.50	2.24	.59	.81	.34	.83	.11	2.68	.68	.05	1.25	1.04	.45	.39	2.13	3.75	9.74	14.66
25	.74	.84	.65	.57	2.80	.59	.85	.36	1.10	.13	3.03	.72	.05	1.32	1.20	.47	.45	2.37	4.02	10.60	16.43
26	1.02	.96	.95	.65	3.58	.57	.90	.40	1.40	.14	3.41	.75	.05	1.41	1.38	.49	.53	2.63	4.28	11.52	18.51
27	1.41	1.08	1.38	.73	4.60	.57	.95	.45	1.78	.15	3.90	.78	.05	1.48	1.56	.53	.55	2.91	4.58	12.44	20.94
28	1.92	1.20	1.89	.80	5.81	.55	.99	.50	2.19	.17	4.40	.81	.05	1.54	1.76	.54	.60	3.21	4.88	13.39	23.60
29	2.40	1.32	2.38	.90	7.00	.55	1.05	.61	2.65	.20	5.06	.84	.05	1.61	2.00	.56	.65	3.54	5.20	14.45	26.51
30	3.04	1.44	2.94	1.02	8.44	.53	1.08	.72	3.13	.22	5.68	.86	.05	1.64	2.22	.59	.69	3.89	5.50	15.44	29.56
31	3.78	1.56	3.56	1.15	10.05	.51	1.14	.83	3.64	.26	6.38	.88	.05	1.74	2.47	.62	.75	4.22	5.85	16.58	33.01
32	4.64	1.71	4.27	1.30	11.92	.48	1.17	.97	4.19	.28	7.09	.91	.05	1.77	2.73	.63	.81	4.55	6.20	17.65	36.66
33	5.44	1.89	5.00	1.40	13.73	.48	1.22	1.19	4.81	.34	8.04	.93	.05	1.85	2.97	.64	.84	4.75	6.70	18.73	40.50
34	6.40	2.10	5.81	1.53	15.84	.46	1.26	1.44	5.47	.38	9.01	.95	.05	1.89	3.22	.67	.89	4.98	7.23	19.88	44.73
35	7.40	2.28	6.67	1.65	18.20	.46	1.30	1.73	6.20	.43	10.12	.97	.08	1.96	3.35	.72	.92	5.20	7.68	20.88	49.20
36	8.51	2.49	7.61	1.80	20.41	.46	1.35	2.05	6.91	.48	11.25	.99	.13	1.99	3.64	.75	.95	5.26	8.13	21.84	53.50
37	9.60	2.64	8.57	1.93	22.74	.46	1.42	2.45	7.67	.53	12.53	1.01	.17	2.06	3.80	.82	.96	5.63	8.18	22.63	57.90
38	10.82	2.82	9.53	2.05	25.22	.46	1.51	2.88	8.42	.59	13.86	1.04	.23	2.08	3.94	.90	.99	6.00	8.03	23.21	62.29
39	11.92	3.03	10.55	2.20	27.70	.46	1.64	3.35	9.20	.66	15.31	1.05	.29	2.11	4.07	.99	1.02	6.53	7.65	23.71	66.72
40	13.22	3.24	11.56	2.35	30.37	.46	1.76	3.87	9.99	.74	16.82	1.08	.36	2.16	4.19	1.08	1.05	7.05	7.28	24.25	71.44
41	14.50	3.45	12.60	2.48	33.03	.46	2.00	4.47	10.80	.85	18.58	1.10	.44	2.18	4.29	1.22	1.07	7.62	6.53	24.45	76.06
42	15.84	3.66	13.64	2.60	35.74	.46	2.07	5.08	11.61	.94	20.16	1.12	.53	2.22	4.42	1.35	1.09	8.20	5.77	24.70	80.60

TABLE 8.—*Value of grades sawed from mature trees of different diameters breasthigh, expressed in dollars and cents.*

(Values in this table obtained as indicated by $.032a_1 + .030b_1 +$ etc. Curves Aval,, Bval, and Cval, shown in Figs. 65, 66 and 67.)

Diameter breasthigh in inches	HIGH GRADES					INTERMEDIATE GRADES						LOW GRADES									Value per tree
	C. & Bet. 6/4	Mldg. Stock	No. 1 Shop 6/4	D. Sel. & Bet. 1″	Total	No. 1 Com. 1″	No. 2 Com. 1″	Shop 1″	No. 2 Shop 6/4	Shims	Total	Box 1″	Cull 2″	Box 6/4	No. 3 Shop 6/4	No. 3 Com. 1″	Plank 3″	4x4 & Lgr.	2x4 & wider No. 1 Dim.	Total	
	$.032a_1+.030b_1+.027c_1+.025d_1=\text{Aval}_1$					$.022e_1+.018f_1+.018g_1+.018h_1+.007i_1=\text{Bval}_1$						$.009j_1+.007k_1+.011l_1+.013m_1+.015n_1+.015o_1+.015p_1+.015q_1=\text{Cval}_1$									B_1
20	.00	.72	.32	.55	1.59	.26	.54	.22	.13	.06	1.21	.47	.06	1.01	.55	.48	.12	1.05	2.93	6.67	9.47
21	.00	.84	.35	.65	1.84	.26	.56	.25	.22	.06	1.35	.49	.06	1.10	.65	.51	.21	1.35	3.12	7.49	10.68
22	.86	.96	.46	.80	3.08	.26	.58	.29	.40	.07	1.60	.54	.06	1.16	.75	.53	.30	1.68	3.30	8.32	13.00
23	1.15	1.08	.59	.90	3.72	.26	.61	.32	.61	.08	1.88	.58	.07	1.26	.88	.53	.37	2.10	3.51	9.31	14.91
24	1.66	1.20	.81	1.00	4.67	.26	.63	.38	.86	.10	2.23	.63	.07	1.34	1.04	.54	.46	2.58	3.75	10.39	17.29
25	2.14	1.32	1.08	1.08	5.62	.26	.65	.43	1.22	.11	2.67	.68	.08	1.43	1.22	.55	.54	3.08	4.03	11.61	19.90
26	2.75	1.47	1.41	1.20	6.82	.26	.67	.54	1.58	.13	3.18	.72	.08	1.52	1.40	.57	.63	3.54	4.28	12.74	22.75
27	3.46	1.59	1.89	1.35	8.29	.26	.68	.63	2.07	.14	3.78	.76	.08	1.60	1.63	.60	.72	3.97	4.62	13.98	26.05
28	4.16	1.74	2.48	1.45	9.83	.26	.72	.76	2.56	.15	4.45	.81	.08	1.70	1.82	.62	.78	4.38	4.92	15.11	29.39
29	4.87	1.86	3.24	1.55	11.52	.26	.74	.94	3.09	.17	5.20	.85	.08	1.76	2.02	.62	.89	4.77	5.25	16.22	32.94
30	5.63	2.04	4.05	1.70	13.42	.24	.76	1.12	3.74	.18	6.04	.90	.09	1.85	2.26	.63	.96	5.10	5.62	17.41	36.87
31	6.59	2.22	4.99	1.80	15.60	.24	.77	1.34	4.42	.20	6.97	.95	.09	1.91	2.50	.63	1.04	5.47	6.00	18.59	41.16
32	7.48	2.40	6.00	1.90	17.78	.24	.79	1.55	5.04	.21	7.83	.99	.10	1.98	2.76	.66	1.11	5.73	6.39	19.72	45.33
33	8.48	2.58	7.10	2.02	20.18	.24	.83	1.91	5.76	.23	8.97	1.04	.10	2.07	3.02	.68	1.17	6.00	6.82	20.90	50.05
34	9.44	2.79	8.23	2.20	22.66	.24	.86	2.30	6.48	.25	10.13	1.08	.11	2.13	3.28	.72	1.23	6.28	7.20	22.03	54.82
35	10.58	3.00	9.46	2.30	25.34	.24	.94	2.70	7.35	.28	11.51	1.12	.11	2.20	3.54	.78	1.26	6.45	7.65	23.11	59.93
36	11.68	3.24	10.92	2.50	28.34	.24	.97	3.24	8.19	.31	12.95	1.15	.11	2.26	3.80	.84	1.31	6.60	8.10	24.17	65.43
37	12.80	3.45	12.42	2.65	31.32	.24	1.01	3.78	9.09	.34	14.46	1.21	.13	2.33	4.06	.90	1.37	6.73	8.55	25.28	71.06
38	14.09	3.72	13.91	2.80	34.52	.22	1.08	4.33	9.99	.36	15.98	1.24	.15	2.40	4.36	.95	1.40	6.78	9.07	26.35	76.85
39	15.20	3.96	15.45	3.00	37.61	.22	1.12	4.93	10.98	.39	17.64	1.28	.17	2.44	4.68	1.05	1.44	6.82	9.59	27.47	82.72
40	16.49	4.27	17.28	3.20	41.24	.22	1.17	5.67	12.03	.43	19.52	1.32	.20	2.51	4.97	1.17	1.50	6.75	10.09	28.51	89.27
41	17.75	4.59	18.95	3.38	44.67	.22	1.26	6.30	13.06	.50	21.34	1.37	.24	2.57	5.27	1.32	1.55	6.68	10.60	29.60	95.61
42	19.20	4.95	20.80	3.60	48.55	.22	1.35	7.13	14.06	.55	23.31	1.41	.29	2.64	5.58	1.50	1.59	6.54	11.18	30.73	102.59
43	20.49	5.40	22.70	3.80	52.39	.22	1.44	7.93	15.20	.62	25.41	1.46	.37	2.69	5.87	1.68	1.64	6.23	11.73	31.67	109.47
44	21.75	5.85	24.60	4.03	56.23	.22	1.55	8.74	16.29	.70	27.50	1.50	.43	2.75	6.16	1.95	1.68	5.79	12.30	32.56	116.29

TABLE 9.—*Volume in cubic feet contained in merchantable portion of immature trees, of different merchantable lengths and diameters breasthigh.*

(Values read from curves shown in Fig. 74.)

Diameter breast-high in inches	MERCHANTABLE LENGTH (FEET)							Height of stump, feet	Basis, No. of trees
	70	80	90	100	110	120	130		
	VOLUME IN CUBIC FEET								
20	63	74	85	97	----------	----------	----------	1.2	11
21	68	80	91	103	----------	----------	----------	1.2	
22	75	86	98	110	123	----------	----------	1.2	39
23	81	93	106	118	131	----------	----------	1.2	
24	88	100	114	127	140	----------	----------	1.3	67
25	95	108	122	136	150	----------	----------	1.3	
26	101	116	131	145	161	176	----------	1.3	92
27	----------	124	140	155	172	188	----------	1.3	
28	----------	133	150	166	183	201	220	1.3	100
29	----------	----------	160	177	196	215	236	1.3	
30	----------	----------	170	189	209	229	252	1.3	65
31	----------	----------	----------	202	222	244	268	1.3	
32	----------	----------	----------	215	236	259	285	1.4	57
33	----------	----------	----------	227	250	275	302	1.4	
34	----------	----------	----------	240	265	291	320	1.3	29
35	----------	----------	----------	----------	280	308	339	1.3	
36	----------	----------	----------	----------	295	325	358	1.4	27
37	----------	----------	----------	----------	----------	343	378	1.4	
38	----------	----------	----------	----------	----------	361	400	1.5	7
39	----------	----------	----------	----------	----------	380	420	1.5	
40	----------	----------	----------	----------	----------	400	441	1.5	8
Total number of trees									502

NOTE.—This table shows total volume in cubic feet inside bark from the stump to a height where the tree is 6″ in diameter outside the bark.

TABLE 10.—*Volume in cubic feet contained in merchantable portion of mature trees, of different merchantable lengths and diameters breasthigh.*

(Values read from curves shown in Fig. 75.)

Diameter breast-high in inches	MERCHANTABLE LENGTH (FEET)								Height of stump, feet	Basis, No. of trees
	80	90	100	110	120	130	140	150		
	VOLUME IN CUBIC FEET									
20	77	87	99	--------	--------	--------	--------	--------	1.1	3
21	85	96	107	--------	--------	--------	--------	--------	1.1	
22	93	105	116	--------	--------	--------	--------	--------	1.1	9
23	102	114	127	--------	--------	--------	--------	--------	1.1	
24	111	124	138	152	--------	--------	--------	--------	1.2	15
25	121	135	149	165	--------	--------	--------	--------	1.2	
26	131	146	162	178	194	--------	--------	--------	1.3	32
27	142	158	175	192	209	--------	--------	--------	1.3	
28	152	170	188	207	225	--------	--------	--------	1.3	39
29	--------	184	203	222	242	--------	--------	--------	1.3	
30	--------	198	218	238	259	282	--------	--------	1.3	33
31	--------	212	233	255	277	301	--------	--------	1.3	
32	--------	226	248	272	295	321	347	--------	1.4	53
33	--------	--------	264	288	314	342	368	--------	1.4	
34	--------	--------	280	307	334	363	392	424	1.4	66
35	--------	--------	297	325	354	385	415	450	1.4	
36	--------	--------	313	344	375	407	440	477	1.4	48
37	--------	--------	--------	363	397	430	466	506	1.4	
38	--------	--------	--------	384	419	454	493	535	1.4	44
39	--------	--------	--------	405	442	479	520	567	1.4	
40	--------	--------	--------	427	465	505	550	599	1.4	28
41	--------	--------	--------	--------	488	532	578	633	1.4	
42	--------	--------	--------	--------	514	559	609	669	1.5	20
43	--------	--------	--------	--------	538	587	640	705	1.5	
44	--------	--------	--------	--------	562	615	674	741	1.5	11
Total number of trees										401

NOTE.—This table shows total volume in cubic feet inside bark from the stump to a height where the tree is 6″ in diameter outside the bark.

TABLE 11.—*Form factors for merchantable portion of immature western yellow pine trees, of different merchantable lengths and diameters breasthigh.*

This table compiled by substituting values given in Table 9 in the following formula:

$$\text{Form factor} = \frac{\text{Vol. cu. ft. contained in merch. lgth. inside bark}}{.7854 \div 144\ (\text{D.B.H.})^2 \times \text{merch. lgth. in feet}}$$

Diameter breast-high in inches	MERCHANTABLE LENGTH (FEET)							Height of stump, feet	Basis, No. of trees
	70	80	90	100	110	120	130		
	FORM FACTORS								
20	.412	.431	.433	.445	----------	----------	----------	1.2	11
21	.405	.417	.421	.429	----------	----------	----------	1.2	
22	.405	.407	.413	.417	.423	----------	----------	1.2	39
23	.401	.402	.408	.410	.413	----------	----------	1.2	
24	.400	.398	.403	.405	.405	----------	----------	1.3	67
25	.397	.396	.397	.399	.399	----------	----------	1.3	
26	.392	.393	.395	.393	.395	.398	----------	1.3	92
27	----------	.390	.392	.390	.390	.393	----------	1.3	
28	----------	.389	.390	.388	.388	.391	.395	1.3	100
29	----------	----------	.388	.386	.388	.390	.396	1.3	
30	----------	----------	.385	.383	.387	.388	.395	1.3	65
31	----------	----------	----------	.386	.385	.388	.394	1.3	
32	----------	----------	----------	.385	.384	.386	.392	1.4	57
33	----------	----------	----------	.383	.383	.386	.391	1.4	
34	----------	----------	----------	.381	.382	.385	.391	1.4	29
35	----------	----------	----------	----------	.381	.384	.390	1.4	
36	----------	----------	----------	----------	.379	.383	.389	1.4	27
37	----------	----------	----------	----------	----------	.382	.389	1.4	
38	----------	----------	----------	----------	----------	.381	.390	1.5	7
39	----------	----------	----------	----------	----------	.381	.389	1.5	
40	----------	----------	----------	----------	----------	.381	.388	1.5	8
Total number of trees									502

TABLE 12.—*Form factors for merchantable portion of mature western yellow pine trees, of different merchantable lengths and diameters breasthigh.*

This table compiled by substituting values given in Table 10 in the following formula:

$$\text{Form factor} = \frac{\text{Vol. cu. ft. contained in merch. lgth. inside bark}}{.7854 \div 144\ (\text{D.B.H.})^2 \times \text{merch. lgth.}}$$

Diameter breast-high in inches	MERCHANTABLE LENGTH (FEET)								Height of stump, feet	Basis, No. of trees
	80	90	100	110	120	130	140	150		
	FORM FACTORS									
20	.442	.443	.453	--------	--------	--------	--------	--------	1.1	3
21	.442	.443	.446	--------	--------	--------	--------	--------	1.1	
22	.442	.443	.440	--------	--------	--------	--------	--------	1.1	9
23	.442	.445	.441	--------	--------	--------	--------	--------	1.1	
24	.442	.439	.440	.440	--------	--------	--------	--------	1.2	15
25	.443	.440	.437	.439	--------	--------	--------	--------	1.2	
26	.444	.440	.439	.439	.438	--------	--------	--------	1.3	32
27	.447	.442	.440	.439	.440	--------	--------	--------	1.3	
28	.445	.442	.440	.439	.438	--------	--------	--------	1.3	39
29	--------	.445	.442	.440	.439	--------	--------	--------	1.3	
30	--------	.448	.444	.441	.439	.442	--------	--------	1.3	33
31	--------	.450	.445	.441	.441	.442	--------	--------	1.3	
32	--------	.450	.445	.442	.440	.442	.444	--------	1.4	53
33	--------	--------	.445	.442	.440	.443	.443	--------	1.4	
34	--------	--------	.445	.443	.442	.443	.444	.447	1.4	66
35	--------	--------	.445	.442	.441	.443	.444	.448	1.4	
36	--------	--------	.443	.442	.441	.442	.445	.450	1.4	48
37	--------	--------	--------	.442	.443	.442	.446	.452	1.4	
38	--------	--------	--------	.442	.442	.442	.447	.452	1.4	44
39	--------	--------	--------	.443	.444	.444	.447	.455	1.4	
40	--------	--------	--------	.445	.444	.445	.450	.456	1.4	28
41	--------	--------	--------	--------	.443	.446	.450	.460	1.4	
42	--------	--------	--------	--------	.444	.446	.451	.463	1.5	20
43	--------	--------	--------	--------	.444	.447	.453	.466	1.5	
44	--------	--------	--------	--------	.443	.448	.455	.468	1.5	11
Total number of trees										401

TABLE 13.—*Volume in board feet, as shown by the Spaulding Log Rule, contained in merchantable portion of immature trees of different merchantable lengths and diameters breasthigh.*

(Values read from curves shown in Fig. 76.)

Diameter breast-high in inches	MERCHANTABLE LENGTH (FEET)							Diameter inside bark top log, inches	Height of stump, feet	Basis, number of trees
	70	80	90	100	110	120	130			
	VOLUME BY SPAULDING LOG SCALE (BD. FT.)									
20	300	380	465	550	---------	---------	---------	6.6	1.2	11
21	325	405	495	580	---------	---------	---------	6.7	1.2	
22	350	435	530	630	730	---------	---------	6.7	1.2	39
23	380	475	570	680	780	---------	---------	6.8	1.2	
24	415	510	620	730	840	---------	---------	6.9	1.3	67
25	450	560	670	785	905	---------	---------	7.0	1.3	
26	490	605	725	845	975	1100	---------	7.1	1.3	92
27	---------	655	780	915	1050	1180	---------	7.1	1.3	
28	---------	710	845	980	1130	1270	1415	7.2	1.3	100
29	---------	---------	910	1060	1210	1365	1520	7.3	1.3	
30	---------	---------	980	1140	1300	1460	1630	7.4	1.3	65
31	---------	---------	---------	1225	1395	1565	1750	7.5	1.3	
32	---------	---------	---------	1310	1490	1675	1870	7.6	1.4	57
33	---------	---------	---------	1400	1585	1780	1990	7.7	1.4	
34	---------	---------	---------	1495	1695	1900	2125	7.8	1.3	29
35	---------	---------	---------	---------	1800	2020	2255	7.9	1.3	
36	---------	---------	---------	---------	1910	2140	2400	8.0	1.4	27
37	---------	---------	---------	---------	---------	2265	2550	8.2	1.4	
38	---------	---------	---------	---------	---------	2395	2700	8.5	1.5	7
39	---------	---------	---------	---------	---------	2525	2850	9.0	1.5	
40	---------	---------	---------	---------	---------	2660	3005	9.6	1.5	8
Total number of trees										502

TABLE 14.—*Volume in board feet, as shown by the Spaulding Log Rule, contained in merchantable portion of mature trees of different merchantable lengths and diameters breasthigh.*

(Values read from curves shown in Fig. 77.)

TABLE 14.

Diameter breast-high in inches	MERCHANTABLE LENGTH (FEET)								Diameter inside bark, top log, inches	Height of stump, feet	Basis, No. of trees
	80	90	100	110	120	130	140	150			
	VOLUME BY SPAULDING LOG SCALE (BD. FT.)										
20	355	455	570	--------	--------	--------	--------	--------	7.2	1.1	3
21	400	500	620	--------	--------	--------	--------	--------	7.4	1.1	
22	455	570	680	--------	--------	--------	--------	--------	7.6	1.1	9
23	510	630	750	--------	--------	--------	--------	--------	7.7	1.1	
24	570	695	820	945	--------	--------	--------	--------	7.9	1.2	15
25	645	770	895	1030	--------	--------	--------	--------	8.1	1.2	
26	720	850	970	1125	1270	--------	--------	--------	8.3	1.3	32
27	795	930	1070	1220	1375	--------	--------	--------	8.5	1.3	
28	875	1020	1170	1320	1480	--------	--------	--------	8.7	1.3	39
29	--------	1110	1270	1425	1600	--------	--------	--------	8.9	1.3	
30	--------	1210	1375	1535	1720	1915	--------	--------	9.1	1.3	33
31	--------	1315	1475	1650	1840	2045	--------	--------	9.3	1.3	
32	--------	1420	1580	1770	1970	2175	2400	--------	9.6	1.4	53
33	--------	--------	1695	1890	2100	2315	2550	--------	9.8	1.4	
34	--------	--------	1805	2010	2230	2455	2700	2950	10.0	1.4	66
35	--------	--------	1930	2145	2370	2610	2875	3150	10.2	1.4	
36	--------	--------	2050	2270	2510	2770	3050	3350	10.4	1.4	48
37	--------	--------	--------	2400	2655	2930	3240	3570	10.7	1.4	
38	--------	--------	--------	2530	2805	3100	3430	3800	11.0	1.4	44
39	--------	--------	--------	2670	2965	3275	3630	4030	11.2	1.4	
40	--------	--------	--------	2805	3125	3460	3840	4280	11.5	1.4	28
41	--------	--------	--------	--------	3280	3650	4060	4530	11.7	1.4	
42	--------	--------	--------	--------	3450	3850	4280	4800	12.1	1.5	20
43	--------	--------	--------	--------	3620	4050	4525	5080	12.4	1.5	
44	--------	--------	--------	--------	3795	4260	4770	5375	12.7	1.5	11
Total number of trees											401

TABLE 15.—*Volume in board feet actually "sawed out" at mill from merchantable portion of immature trees of different merchantable lengths and diameters breast-high.*

(Values read from curves shown in Fig. 78.)

Diameter breast-high in inches	MERCHANTABLE LENGTH (FEET)							Diameter inside bark, top log, inches	Height of stump, feet	Basis, No. of trees
	70	80	90	100	110	120	130			
	VOLUME "SAWED OUT" (BOARD FEET)									
20	475	580	675	790	---------	---------	---------	6.6	1.2	11
21	520	625	730	840	---------	---------	---------	6.7	1.2	
22	560	675	790	900	1020	---------	---------	6.7	1.2	39
23	610	730	850	970	1095	---------	---------	6.8	1.2	
24	665	790	915	1045	1170	---------	---------	6.9	1.3	67
25	720	850	990	1120	1255	---------	---------	7.0	1.3	
26	780	920	1060	1200	1350	1505	---------	7.1	1.3	92
27	---------	990	1140	1285	1445	1610	---------	7.1	1.3	
28	---------	1060	1220	1380	1545	1730	1920	7.2	1.3	100
29	---------	---------	1315	1480	1650	1845	2050	7.3	1.3	
30	---------	---------	1400	1585	1760	1965	2195	7.4	1.3	65
31	---------	---------	---------	1685	1875	2090	2340	7.5	1.3	
32	---------	---------	---------	1795	2000	2225	2490	7.6	1.4	57
33	---------	---------	---------	1900	2120	2365	2645	7.7	1.4	
34	---------	---------	---------	2005	2250	2500	2800	7.8	1.3	29
35	---------	---------	---------	---------	2380	2650	2960	7.9	1.3	
36	---------	---------	---------	---------	2500	2795	3130	8.0	1.4	27
37	---------	---------	---------	---------	---------	2945	3300	8.2	1.4	
38	---------	---------	---------	---------	---------	3100	3480	8.5	1.5	7
39	---------	---------	---------	---------	---------	3250	3660	9.0	1.5	
40	---------	---------	---------	---------	---------	3400	3850	9.6	1.5	8
Total number of trees										502

TABLE 16.—*Volume in board feet actually "sawed out" at mill from merchantable portion of mature trees of different merchantable lengths and diameters breasthigh.*

(Values read from curves shown in Fig. 79.)

Diameter breast-high in inches	MERCHANTABLE LENGTH (FEET)								Diameter inside bark, top log, inches	Height of stump, feet	Basis, No. of trees
	80	90	100	110	120	130	140	150			
	VOLUME "SAWED OUT" (BOARD FEET)										
20	550	690	835	--------	--------	--------	--------	--------	7.2	1.1	3
21	610	760	905	--------	--------	--------	--------	--------	7.4	1.1	
22	680	830	985	--------	--------	--------	--------	--------	7.6	1.1	9
23	760	920	1075	--------	--------	--------	--------	--------	7.7	1.1	
24	840	1005	1165	1345	--------	--------	--------	--------	7.9	1.2	15
25	925	1095	1260	1440	--------	--------	--------	--------	8.1	1.2	
26	1020	1190	1370	1550	1750	--------	--------	--------	8.3	1.3	32
27	1120	1295	1480	1665	1875	--------	--------	--------	8.5	1.3	
28	1220	1400	1595	1795	2010	--------	--------	--------	8.7	1.3	39
29	--------	1515	1710	1925	2145	--------	--------	--------	8.9	1.3	
30	--------	1625	1835	2060	2290	2530	--------	--------	9.1	1.3	33
31	--------	1745	1960	2200	2435	2690	--------	--------	9.3	1.3	
32	--------	1860	2090	2335	2590	2850	3140	--------	9.6	1.4	53
33	--------	--------	2220	2480	2750	3025	3325	--------	9.8	1.4	
34	--------	--------	2360	2620	2900	3200	3520	3850	10.0	1.4	66
35	--------	--------	2500	2770	3070	3385	3725	4075	10.2	1.4	
36	--------	--------	2645	2925	3235	3580	3930	4320	10.4	1.4	48
37	--------	--------	--------	3080	3400	3770	4155	4570	10.7	1.4	
38	--------	--------	--------	3245	3585	3975	4380	4825	11.0	1.4	44
39	--------	--------	--------	3400	3770	4185	4620	5085	11.2	1.4	
40	--------	--------	--------	3575	3960	4400	4860	5360	11.5	1.4	28
41	--------	--------	--------	--------	4150	4620	5120	5650	11.7	1.4	
42	--------	--------	--------	--------	4350	4845	5370	5945	12.1	1.5	20
43	--------	--------	--------	--------	4550	5075	5635	6240	12.4	1.5	
44	--------	--------	--------	--------	4750	5315	5910	6550	12.7	1.5	11
Total number of trees											401

TABLE 17.—*Value in dollars and cents of lumber actually "sawed out" at mill from merchantable portion of immature trees of different merchantable lengths and diameters breasthigh.*

(This table compiled by applying the "value per 1000 board feet determinations," given in Fig. 70, Curve "C," to Table 15.)

Diameter breast-high in inches	MERCHANTABLE LENGTH (FEET)							Diameter inside bark, top log, inches	Height of stump, feet	Basis, No. of trees
	70	80	90	100	110	120	130			
	VALUE IN DOLLARS AND CENTS									
20	7.00	8.50	9.90	11.60	---------	---------	---------	6.6	1.2	11
21	7.70	9.30	10.80	12.50	---------	---------	---------	6.7	1.2	
22	8.40	10.10	11.80	13.50	15.30	---------	---------	6.7	1.2	39
23	9.20	11.10	12.90	14.70	16.60	---------	---------	6.8	1.2	
24	10.20	12.10	14.00	16.00	18.00	---------	---------	6.9	1.3	67
25	11.20	13.20	15.40	17.40	19.50	---------	---------	7.0	1.3	
26	12.30	14.50	16.70	18.90	21.10	23.70	---------	7.1	1.3	92
27	---------	15.90	18.30	20.60	23.20	25.80	---------	7.1	1.3	
28	---------	17.30	19.90	22.60	25.30	28.30	31.40	7.2	1.3	100
29	---------	---------	21.80	24.60	27.40	30.70	34.00	7.3	1.3	
30	---------	---------	23.60	26.70	29.60	33.10	37.00	7.4	1.3	65
31	---------	---------	---------	28.80	32.00	35.80	40.00	7.5	1.3	
32	---------	---------	---------	31.00	34.60	38.50	43.10	7.6	1.4	57
33	---------	---------	---------	33.20	37.10	41.40	46.30	7.7	1.4	
34	---------	---------	---------	35.60	39.80	44.20	49.60	7.8	1.3	29
35	---------	---------	---------	---------	42.60	47.50	53.00	7.9	1.3	
36	---------	---------	---------	---------	45.20	50.50	56.50	8.0	1.4	27
37	---------	---------	---------	---------	---------	53.80	60.20	8.2	1.4	
38	---------	---------	---------	---------	---------	57.00	64.00	8.5	1.5	7
39	---------	---------	---------	---------	---------	60.30	68.00	9.0	1.5	
40	---------	---------	---------	---------	---------	63.60	72.00	9.6	1.5	[illegible]
Total number of trees										502

TABLE 18.—*Value in dollars and cents of lumber actually "sawed out" at mill from merchantable portion of mature trees of different merchantable lengths and diameters breasthigh.*

(This table compiled by applying the "value per 1000 board feet determination," given in Fig. 72, Curve "C_1", to Table 16.)

Diameter breast-high in inches	MERCHANTABLE LENGTH (FEET)								Diameter inside bark, top log, inches	Height of stump, feet	Basis, No. of trees
	80	90	100	110	120	130	140	150			
	VALUE IN DOLLARS AND CENTS										
20	8.30	10.40	12.60	--------	--------	--------	--------	--------	7.2	1.1	3
21	9.50	11.80	14.00	--------	--------	--------	--------	--------	7.4	1.1	
22	10.70	13.10	15.60	--------	--------	--------	--------	--------	7.6	1.1	9
23	12.20	14.80	17.30	--------	--------	--------	--------	--------	7.7	1.1	
24	13.70	16.70	19.00	21.40	--------	--------	--------	--------	7.9	1.2	15
25	15.30	18.10	20.80	23.40	--------	--------	--------	--------	8.1	1.2	
26	17.10	20.00	23.00	26.00	29.40	--------	--------	--------	8.3	1.3	32
27	19.10	22.10	25.20	28.40	32.00	--------	--------	--------	8.5	1.3	
28	21.00	24.20	27.50	31.00	34.70	--------	--------	--------	8.7	1.3	39
29	--------	26.50	29.90	33.70	37.60	--------	--------	--------	8.9	1.3	
30	--------	28.80	32.50	36.50	40.50	44.80	--------	--------	9.1	1.3	33
31	--------	31.10	35.10	39.40	43.70	48.20	--------	--------	9.3	1.3	
32	--------	33.70	37.80	42.30	46.80	51.60	53.80	--------	9.6	1.4	53
33	--------	--------	40.60	45.40	50.30	55.80	61.30	--------	9.8	1.4	
34	--------	--------	43.70	48.50	53.70	59.20	65.10	71.20	10.0	1.4	66
35	--------	--------	46.70	51.80	57.30	63.20	69.50	76.00	10.2	1.4	
36	--------	--------	49.60	54.90	60.60	67.10	73.70	81.00	10.4	1.4	48
37	--------	--------	--------	58.20	64.30	71.20	78.50	86.50	10.7	1.4	
38	--------	--------	--------	61.70	68.20	75.50	83.30	91.70	11.0	1.4	44
39	--------	--------	--------	65.10	72.20	80.10	88.50	97.50	11.2	1.4	
40	--------	--------	--------	67.90	76.20	84.70	93.50	103.20	11.5	1.4	28
41	--------	--------	--------	--------	80.40	89.50	99.10	109.20	11.7	1.4	
42	--------	--------	--------	--------	84.70	94.40	104.80	115.70	12.1	1.5	20
43	--------	--------	--------	--------	88.70	99.00	109.90	121.60	12.4	1.5	
44	--------	--------	--------	--------	92.90	104.00	115.60	128.10	12.7	1.5	11
Total number of trees											401

TABLE 19.—*Average volume sawed out by grades from merchantable portion of immature trees of different merchantable lengths and diameters breasthigh.*

Diameter breasthigh in inches	MERCHANTABLE LENGTH (FEET)																				
	70			80			90			100			110			120			130		
	VOLUME SAWED OUT BY GRADES (BOARD FEET)																				
	High	*Int.*	**Low*	*High*	*Int.*	*Low*	*High*	*Int.*	*Low*	*High*	*Int.*	*Low*	*High*	*Int.*	*Low*	*High*	*Int.*	*Low*	*High*	*Int.*	*Low*
20	20	65	390	25	80	475	29	94	552	33	110	647									
21	28	74	418	33	89	503	39	104	587	45	120	675									
22	34	83	443	41	100	534	48	117	625	55	133	712	62	151	807						
23	43	95	472	52	113	565	61	132	657	69	151	750	78	170	847						
24	54	107	504	64	127	599	75	146	694	85	167	793	96	188	886						
25	66	118	536	79	139	632	92	162	736	103	184	833	116	205	934						
26	83	130	567	98	154	668	113	177	770	128	200	872	144	226	980	160	252	1093			
27				122	171	697	140	196	804	157	222	906	177	249	1019	197	278	1135			
28				148	187	725	171	216	833	193	244	943	216	274	1055	242	306	1182	269	339	1312
29							200	240	875	225	270	985	250	302	1098	280	337	1228	311	375	1364
30							233	263	904	264	298	1023	294	331	1135	328	369	1268	366	413	1416
31										303	323	1059	338	360	1177	376	402	1312	421	449	1470
32										349	352	1094	389	393	1218	433	437	1355	484	488	1518
33										389	386	1125	434	432	1254	484	483	1398	542	538	1565
34										433	420	1152	485	472	1293	540	524	1436	605	587	1608
35													538	516	1326	598	574	1478	669	641	1650
36													594	559	1347	665	625	1505	745	700	1685
37																725	685	1535	812	768	1720
38																795	749	1556	892	840	1748
39																860	816	1574	968	919	1773
40																927	885	1588	1050	1002	1798

NOTE.—The diameter inside bark, height of stump, and basis are same as in Table No. 17.

*For classification of high, intermediate, and low grades, see Table 3.

TABLE 20.—*Average volume sawed out by grades from merchantable portion of mature trees of different merchantable lengths and diameters breasthigh.*

Diameter breasthigh in inches	MERCHANTABLE LENGTH (FEET)																							
	80			90			100			110			120			130			140			150		
	VOLUME SAWED OUT BY GRADES (BOARD FEET)																							
	High	*Int.*	**Low*	*High*	*Int.*	*Low*	*High*	*Int.*	*Low*	*High*	*Int.*	*Low*	*High*	*Int.*	*Low*	*High*	*Int.*	*Low*	*High*	*Int.*	*Low*	*High*	*Int.*	*Low*
20	51	60	439	64	76	550	77	92	666	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------
21	58	68	484	72	84	604	86	101	718	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------
22	90	76	514	110	93	627	130	110	745	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------
23	106	90	564	128	109	683	150	127	798	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------
24	128	103	609	153	123	729	177	143	845	205	164	976	------	------	------	------	------	------	------	------	------	------	------	------
25	149	120	656	176	142	777	203	163	894	232	186	1022	------	------	------	------	------	------	------	------	------			
26	176	139	705	206	162	822	237	187	946	268	211	1071	302	238	1210	------	------	------	------	------	------	------	------	------
27	208	161	751	241	186	868	275	212	993	309	239	1117	348	269	1258	------	------	------	------	------	------	------	------	------
28	242	185	793	278	212	910	316	241	1038	356	272	1167	398	304	1308	------	------	------	------	------	------	------	------	------
29	------	------	------	318	242	955	359	273	1078	404	307	1214	450	342	1353	------	------	------	------	------	------	------	------	------
30	------	------	------	360	272	993	406	307	1122	456	344	1230	506	382	1402	559	423	1548						
31	------	------	------	408	304	1033	458	342	1160	514	384	1302	569	425	1441	628	470	1592	------	------	------	------	------	------
32	------	------	------	454	334	1072	511	376	1203	571	420	1344	633	466	1491	696	513	1641	766	565	1809	------	------	------
33	------	------	------	------	------	------	564	418	1238	630	468	1382	698	518	1534	768	570	1687	845	627	1853	------	------	------
34	------	------	------	------	------	------	620	466	1274	688	514	1418	763	569	1568	841	627	1732	926	690	1904	1012	755	2083
35	------	------	------	------	------	------	677	512	1311	750	568	1452	830	630	1610	916	694	1775	1009	764	1952	1102	835	2138
36	------	------	------	------	------	------	742	564	1339	820	624	1481	907	690	1638	1004	764	1812	1102	838	1990	1210	922	2188
37	------	------	------	------	------	------	------	------	------	887	681	1512	979	751	1670	1086	834	1850	1196	918	2041	1317	1010	2248
38	------	------	------	------	------	------	------	------	------	961	738	1546	1061	814	1710	1175	904	1896	1295	995	2090	1426	1099	2300
39	------	------	------	------	------	------	------	------	------	1022	798	1580	1134	885	1751	1260	980	1945	1389	1083	2148	1530	1193	2362
40	------	------	------				------	------	------	1100	865	1610	1218	958	1784	1353	1004	1983	1495	1177	2188	1650	1298	2412
41	------	------	------	------	------	------	------	------	------	------	------	------	1300	1030	1820	1447	1147	2026	1603	1270	2247	1770	1402	2478
42	------	------	------	------	------	------	------	------	------	------	------	------	1384	1104	1862	1540	1230	2075	1710	1363	2297	1890	1510	2545
43	------	------	------	------	------	------	------	------	------	------	------	------	1472	1187	1891	1642	1323	2110	1820	1470	2345	2020	1628	2592
44	------	------	------	------	------	------	------	------	------	------	------	------	1560	1270	1920	1743	1420	2152	1940	1580	2390	2150	1750	2650

NOTE.—The diameter inside bark, height of stump, and basis are same as in Table No. 18.
*For classification of high, intermediate, and low grades, see Table 4.

TABLE 21.—*Growth in volume and value of immature western yellow pine.*

(Values read from curves shown in Figs. 4, 11, 68, 70, 87, 88, 91 and 92.)

Diameter breast-high in inches	Average merch. length in feet	Volume in board feet	Value per tree	Average value per 1000 bd. ft.	Increase in volume (board feet) per decade			% increase in volume per decade			Increase in value per decade			% increase in value per decade		
					Lowest 10%	Average	Highest 10%	Lowest 10%	Average	Highest 10%	Lowest 10%	Average	Highest 10%	Lowest 10%	Average	Highest 10%
20	84	685	$10.10	$14.75	20	50	82	3.1	7.4	11.8	$.40	$.80	$1.15	3.9	7.4	10.8
21	87	735	10.90	14.85	22	55	88	3.1	7.5	12.1	.40	.85	1.25	3.9	7.6	11.8
22	89	790	11.85	15.00	25	65	105	3.3	8.0	12.8	.45	1.00	1.60	4.0	8.4	13.2
23	91	870	13.00	15.15	30	80	130	3.5	8.8	14.2	.55	1.30	2.00	4.1	9.7	14.8
24	94	955	14.65	15.35	37	97	160	4.0	9.9	16.2	.65	1.45	2.60	4.4	11.5	17.3
25	96	1060	16.30	15.55	46	116	190	4.4	10.8	17.8	.80	2.15	3.30	4.7	12.9	19.9
26	99	1175	18.50	15.75	54	136	223	4.8	11.5	18.9	1.00	2.55	4.00	5.3	13.7	21.5
27	101	1300	20.70	16.05	64	155	253	5.1	12.0	19.4	1.25	2.95	4.70	6.0	14.0	22.2
28	104	1445	23.60	16.35	73	174	282	5.2	12.3	19.5	1.45	3.35	5.30	6.3	14.0	22.4
29	106	1585	26.50	16.60	82	194	310	5.2	12.3	19.4	1.65	3.70	5.90	6.4	13.8	22.2
30	108	1755	29.55	16.85	89	210	340	5.0	12.0	19.2	1.85	4.00	6.50	6.3	13.5	21.7
31	110	1925	33.00	17.10	95	226	366	4.8	11.7	18.6	2.00	4.35	7.00	6.0	13.0	21.0
32	112	2115	36.65	17.30	100	238	388	4.6	11.2	18.0	2.10	4.60	7.45	5.6	12.4	20.3
33	115	2315	40.60	17.50	104	246	405	4.4	10.5	17.2	2.15	4.80	7.85	5.2	11.7	19.2
34	117	2525	44.75	17.70	105	250	418	4.1	9.8	16.3	2.20	4.95	8.20	4.7	11.0	18.2
35	119	2735	48.90	17.90	105	250	422	3.8	9.2	15.3	2.15	5.05	8.45	4.3	10.3	17.0
36	121	2960	53.50	18.05	103	249	422	3.5	8.4	14.2	2.10	5.10	8.60	3.8	9.5	15.9
37	123	3160	57.75	18.25	99	246	420	3.1	7.7	13.1	2.00	5.05	8.70	3.4	8.7	14.8
38	125	3380	62.30	18.40	92	240	415	2.8	7.0	12.1	1.90	5.00	8.65	3.0	8.0	13.7
39	127	3600	66.90	18.55	84	233	410	2.4	6.4	11.1	1.80	4.95	8.45	2.7	7.3	12.7
40	129	3825	71.45	18.70	75	224	402	2.0	5.8	10.2	1.70	4.75	8.25	2.3	6.6	11.6
41	131	4040	76.00	18.85	65	214	390	1.6	5.2	9.5	1.55	4.55	8.00	2.0	5.9	10.6
42	133	4260	80.60	18.95	54	203	380	1.2	4.6	8.8	1.40	4.25	7.70	1.7	5.2	9.5

TABLE 22.—*Growth in volume and value of mature western yellow pine.*

(Values read from curves shown in Figs. 5, 13, 69, 72, 89, 90, 93 and 94.)

Diameter breast-high in inches	Average merch. length in feet	Volume in board feet	Value per tree	Average value per 1000 bd. ft.	Increase in volume (board feet) per decade			% increase in volume per decade			Increase in value per decade			% increase in value per decade		
					Lowest 10%	Average	Highest 10%	Lowest 10%	Average	Highest 10%	Lowest 10%	Average	Highest 10%	Lowest 10%	Average	Highest 10%
20	83	625	$9.50	$15.10	15	31	48	2.3	5.0	7.7	$.25	$.60	$.87	2.7	6.0	9.2
21	87	715	11.00	15.50	16	34	55	2.4	5.1	7.9	.30	.68	1.00	2.7	6.0	9.4
22	91	820	13.00	15.80	19	40	66	2.4	5.2	8.1	.35	.72	1.25	2.8	6.2	9.6
23	94	930	15.00	16.05	22	50	80	2.5	5.4	8.5	.42	.95	1.50	2.8	6.4	10.1
24	97	1060	17.30	16.30	28	60	96	2.6	5.7	9.0	.50	1.15	1.85	2.9	6.6	10.6
25	100	1200	20.00	16.55	34	71	113	2.7	5.9	9.4	.55	1.35	2.20	2.9	6.7	11.0
26	103	1360	22.75	16.80	40	82	131	2.9	6.0	9.6	.65	1.60	2.55	3.0	6.8	11.2
27	105	1525	26.00	17.05	45	92	149	3.0	6.0	9.7	.75	1.80	2.90	3.0	6.8	11.2
28	107	1700	29.40	17.25	50	101	166	3.0	6.0	9.7	.87	2.00	3.27	3.0	6.7	11.0
29	110	1880	32.90	17.50	55	110	183	3.0	6.0	9.6	1.00	2.20	3.60	3.0	6.6	10.9
30	112	2080	36.80	17.70	60	120	200	2.9	5.9	9.5	1.10	2.38	4.00	3.0	6.5	10.7
31	114	2290	40.75	17.90	64	130	216	2.8	5.8	9.4	1.18	2.58	4.30	2.9	6.3	10.5
32	117	2500	45.10	18.10	69	139	232	2.7	5.6	9.3	1.25	2.75	4.60	2.8	6.1	10.2
33	119	2735	49.60	18.30	72	148	248	2.6	5.5	9.1	1.33	2.90	4.90	2.7	5.9	9.9
34	121	2970	54.60	18.50	75	155	263	2.5	5.3	8.8	1.40	3.08	5.20	2.6	5.7	9.5
35	123	3220	59.75	18.65	78	162	277	2.4	5.1	8.6	1.45	3.20	5.50	2.4	5.4	9.2
36	125	3480	65.40	18.75	80	169	290	2.2	4.9	8.3	1.50	3.35	5.75	2.3	5.2	8.8
37	127	3750	71.00	18.90	80	175	303	2.1	4.7	8.0	1.55	3.50	6.00	2.2	5.0	8.4
38	129	4030	76.85	19.00	80	180	314	2.0	4.5	7.7	1.58	3.65	6.20	2.1	4.7	8.0
39	131	4320	83.00	19.15	81	184	322	1.9	4.3	7.4	1.62	3.75	6.35	2.0	4.5	7.7
40	133	4625	89.25	19.25	82	188	328	1.8	4.0	7.1	1.66	3.85	6.50	1.9	4.3	7.3
41	135	4940	95.80	19.35	82	190	330	1.7	3.8	6.7	1.70	3.92	6.60	1.8	4.1	6.9
42	137	5270	102.50	19.45	82	190	332	1.6	3.6	6.3	1.73	4.00	6.70	1.7	3.8	6.5
43	138	5590	109.30	19.50	82	190	332	1.5	3.4	6.0	1.73	4.03	6.72	1.6	3.6	6.2
44	140	5930	116.25	19.55	82	191	332	1.4	3.2	5.6	1.73	4.05	6.73	1.5	3.4	5.8

AVERAGE VALUES FOR 16′ BUTT LOGS.

TABLE 23.—*Volume in board feet of each grade actually "sawed out" at mill from 16′ butt logs of immature western yellow pine trees of different diameters breasthigh.*

(Values read from curves shown on left-hand pages, Nos. 90 to 100, inclusive.)

Diameter breasthigh in inches	HIGH GRADES					INTERMEDIATE GRADES						LOW GRADES									Total sawed out, all grades
	C. & Bet. 6/4	Mldg. Stock	No. 1 Shop 6/4	D. Sel. & Bet. 1″	Total	No. 1 Com. 1″	No. 2 Com. 1″	Shop 1″	No. 2 Shop 6/4	Shims	Total	Box 1″	Cull 2″	Box 6/4	No. 3 Shop 6/4	No. 3 Com. 1″	Plank 3″	4x4 & Lgr.	2x4 & wider No. 1 Dim.	Total	
	a′ +	b′ +	c′ +	d′ =	Av′	e′ +	f′ +	g′ +	h′ +	i′ =	Bv′	j′ +	k′ +	l′ +	m′ +	n′ +	o′ +	p′ +	q′ =	Cv′	A′
20	3	9	4	7	23	10	11	7	7	3	38	13	5	35	18	9	7	11	50	148	209
21	5	10	5	10	30	10	12	7	13	3	45	12	5	34	23	9	7	11	52	153	228
22	8	11	6	12	37	10	12	7	20	4	53	11	5	34	27	9	7	11	54	158	248
23	12	12	8	15	47	10	13	7	27	4	61	10	5	33	28	9	7	11	57	160	268
24	17	13	12	18	60	10	13	7	32	5	67	10	5	33	31	9	7	12	60	167	294
25	24	15	16	20	75	10	14	8	37	5	74	9	5	32	32	9	7	12	62	168	317
26	31	16	21	22	90	10	15	8	41	5	79	9	5	32	33	9	7	12	65	170	339
27	41	18	28	25	112	10	15	9	46	6	86	8	5	31	34	10	7	12	68	175	373
28	50	20	35	28	133	10	16	9	50	6	91	8	5	30	34	10	7	13	70	177	401
29	62	21	41	30	154	10	17	10	54	7	98	7	5	30	33	10	7	14	72	178	430
30	76	22	50	32	180	10	17	10	56	7	100	7	5	30	33	10	7	16	76	184	464
31	88	24	57	35	204	9	18	10	58	7	102	7	6	29	32	10	7	17	82	190	496
32	101	26	65	37	229	9	18	11	59	8	105	6	7	29	31	10	7	18	85	193	527
33	114	28	75	39	256	9	19	14	60	8	110	6	8	28	30	10	7	20	90	199	565
34	132	30	84	41	287	9	20	20	60	8	117	6	9	28	28	10	7	20	96	204	608
35	150	32	93	42	317	9	20	28	61	9	127	6	10	27	26	11	7	20	101	208	652
36	166	34	102	44	346	8	20	38	61	9	136	6	11	27	24	11	7	20	105	211	693
37	182	36	113	45	376	8	21	51	61	9	150	6	13	26	23	11	7	19	108	213	739
38	198	39	121	47	405	8	21	67	61	10	167	6	16	25	22	11	6	18	107	211	783
39	217	41	132	49	439	7	21	85	60	12	185	6	18	25	20	11	6	16	104	206	830
40	236	43	142	50	471	7	22	103	60	14	206	6	20	24	19	11	6	14	101	201	879
41	250	46	153	51	500	7	22	126	60	17	232	6	23	24	18	11	6	12	97	197	929
42	266	50	163	52	531	7	23	148	59	21	258	6	26	23	16	11	6	9	91	188	977

TABLE 24.—*Volume in board feet of each grade actually "sawed out" at mill from 16′ butt logs of mature western yellow pine trees of different diameters breasthigh.*

(Values read from curves shown on right-hand pages Nos. 91 to 101, inclusive.)

Diameter breasthigh in inches	HIGH GRADES					INTERMEDIATE GRADES						LOW GRADES									Total sawed out, all grades
	C. & Bet. 6/4	Mldg. Stock	No. 1 Shop 6/4	D. Sel. & Bet. 1″	Total	No. 1 Com. 1″	No. 2 Com. 1″	Shop 1″	No. 2 Shop 6/4	Shims	Total	Box 1″	Cull 2″	Box 6/4	No. 3 Shop 6/4	No. 3 Com. 1″	Plank 3″	4x4 & Lgr.	2x4 & wider No. 1 Dim.	Total	
	a_1' +	b_1' +	c_1' +	d_1'	$= Av_1'$	e_1' +	f_1' +	g_1' +	h_1' +	i_1'	$= Bv_1'$	j_1' +	k_1' +	l_1' +	m_1' +	n_1' +	o_1' +	p_i' +	p_1'	$= Cv_1'$	A'_1
20	0	13	16	10	39	7	11	4	10	4	36	9	7	42	18	10	0	3	45	134	209
21	11	14	18	13	56	7	11	5	11	4	38	9	7	41	18	10	0	3	52	140	234
22	21	16	20	16	73	6	11	5	12	4	38	9	7	41	18	10	0	4	60	149	260
23	33	17	23	18	91	6	11	6	13	4	40	9	7	40	18	10	0	4	67	155	286
24	46	18	26	21	111	6	11	6	15	4	42	9	7	39	18	10	0	5	73	161	314
25	56	20	29	24	129	5	11	7	17	5	45	9	7	39	19	10	0	6	80	170	344
26	68	21	32	27	148	5	11	8	20	5	49	9	8	38	19	10	0	7	86	177	374
27	81	22	36	30	169	5	11	9	23	5	53	9	8	38	20	11	0	8	91	183	405
28	96	23	40	32	191	5	11	10	26	5	57	9	8	37	20	11	0	9	97	191	439
29	109	24	43	34	210	4	11	11	30	6	62	9	9	36	20	11	0	10	102	197	469
30	122	25	47	36	230	4	11	13	34	6	68	9	9	35	20	11	0	11	107	202	500
31	137	27	51	38	253	4	11	17	38	6	76	9	9	34	21	11	0	12	110	206	535
32	151	28	56	41	276	4	11	22	43	7	87	9	10	33	21	11	0	15	113	212	575
33	166	30	63	43	302	4	11	29	48	7	99	9	10	32	23	11	0	18	116	219	620
34	180	32	70	45	327	4	11	36	54	7	112	9	10	31	24	11	0	21	117	223	662
35	195	34	78	47	354	3	11	44	57	8	123	9	10	30	26	12	0	24	117	228	705
36	210	36	85	49	380	3	11	53	63	9	139	9	10	29	29	12	0	28	116	233	752
37	224	38	94	51	407	3	11	64	69	9	156	9	11	29	31	12	0	32	113	237	800
38	239	40	102	53	434	3	11	75	73	10	172	9	11	28	33	12	0	36	109	238	844
39	253	43	114	55	465	3	11	88	80	10	192	9	11	28	36	12	0	39	101	236	893
40	269	46	128	57	500	3	12	100	85	11	211	9	12	27	38	13	0	43	93	235	946
41	284	49	144	58	535	3	12	113	91	11	230	9	13	26	40	13	0	47	83	231	996
42	301	52	162	59	574	3	13	128	97	12	256	9	15	25	42	13	0	51	70	225	1052
43	320	55	184	60	619	3	14	143	104	12	276	9	18	24	45	13	0	56	57	222	1137
44	338	59	206	60	663	3	14	159	110	13	299	9	21	23	48	13	0	62	44	220	1182

TABLE 25.—*Grades sawed from 16′ butt logs of immature trees of different diameters breasthigh, expressed in per cent of total sawed out.*

(Values in this table obtained as indicated by $\frac{100a'}{A'} + \frac{100b'}{A'} + \text{etc.}$ Curves Ap₁′, Bp₁′, and Cp₁′ shown in Figs. 139, 140 and 141.)

Diameter breasthigh in inches	HIGH GRADES					INTERMEDIATE GRADES						LOW GRADES									Total sawed out, all grades
	C. & Bet. 6/4	Mldg. Stock	No. 1 Shop 6/4	D. Sel. & Bet. 1″	Total	No. 1 Com. 1″	No. 2 Com. 1″	Shop 1″	No. 2 Shop 6/4	Shims	Total	Box 1″	Cull 2″	Box 6/4	No. 3 Shop 6/4	No. 3 Com. 1″	Plank 3″	4x4 & Lgr.	2x4 & wider No. 1 Dim.	Total	
	$\frac{100a'}{A'}$ +	$\frac{100b'}{A'}$ +	$\frac{100c'}{A'}$ +	$\frac{100d'}{A'}$ =	Ap′	$\frac{100e'}{A'}$ +	$\frac{100f'}{A'}$ +	$\frac{100g'}{A'}$ +	$\frac{100h'}{A'}$ +	$\frac{100i'}{A'}$ =	Bp′	$\frac{100j'}{A'}$ +	$\frac{100k'}{A'}$ +	$\frac{100l'}{A'}$ +	$\frac{100m'}{A'}$ +	$\frac{100n'}{A'}$ +	$\frac{100o'}{A'}$ +	$\frac{100p'}{A'}$ +	$\frac{100q'}{A'}$ =	Cp′	A′
20	1.4	4.4	1.9	3.4	11.1	4.8	5.3	3.4	3.3	1.4	18.2	6.2	2.4	16.7	8.6	4.3	3.3	5.3	23.9	70.7	209
21	2.2	4.4	2.1	4.4	13.1	4.4	5.3	3.1	5.7	1.3	19.8	5.3	2.2	14.9	10.1	3.9	3.1	4.8	22.8	67.1	228
22	3.2	4.4	2.4	4.8	14.8	4.0	4.8	2.8	8.1	1.6	21.3	4.4	2.1	13.7	10.9	3.7	2.9	4.4	21.8	63.9	248
23	4.5	4.5	3.0	5.6	17.6	3.7	4.8	2.6	10.1	1.5	22.7	3.7	1.9	12.3	10.4	3.4	2.6	4.1	21.3	59.7	268
24	5.8	4.4	4.1	6.1	20.4	3.4	4.4	2.4	10.9	1.7	22.8	3.4	1.7	11.2	10.5	3.1	2.4	4.1	20.4	56.8	294
25	7.6	4.7	5.0	6.3	23.6	3.2	4.4	2.5	11.7	1.6	23.4	2.8	1.6	10.1	10.1	2.8	2.2	3.8	19.6	53.0	317
26	9.1	4.7	6.2	6.4	26.4	2.9	4.4	2.3	12.0	1.5	23.1	2.6	1.5	9.4	9.7	2.6	2.1	3.5	19.1	50.5	339
27	11.0	4.8	7.5	6.7	30.0	2.7	4.1	2.4	12.3	1.6	23.1	2.1	1.3	8.3	9.1	2.7	1.9	3.2	18.3	46.9	373
28	12.5	5.0	8.7	7.0	33.2	2.5	4.0	2.2	12.5	1.5	22.7	2.0	1.2	7.5	8.5	2.5	1.7	3.2	17.5	44.1	401
29	14.4	4.9	9.4	7.0	35.7	2.3	4.0	2.3	12.6	1.5	22.7	1.6	1.2	7.0	7.8	2.3	1.6	3.3	16.8	41.6	430
30	16.4	4.7	10.8	6.9	38.8	2.1	3.7	2.1	12.1	1.5	21.5	1.5	1.2	6.5	7.1	2.1	1.5	3.4	16.4	39.7	464
31	17.8	4.8	11.5	7.1	41.2	1.8	3.6	2.0	11.7	1.4	20.5	1.4	1.2	5.8	6.5	2.0	1.4	3.4	16.6	38.3	496
32	19.2	4.9	12.3	7.0	43.4	1.7	3.4	2.1	11.2	1.5	19.9	1.2	1.3	5.5	5.9	1.9	1.3	3.4	16.2	36.7	527
33	20.2	5.0	13.3	6.9	45.4	1.6	3.3	2.5	10.6	1.4	19.4	1.1	1.4	5.0	5.3	1.8	1.2	3.5	15.9	35.2	565
34	21.8	4.9	13.8	6.7	47.2	1.5	3.3	3.3	9.9	1.3	19.3	1.0	1.5	4.6	4.6	1.6	1.1	3.3	15.8	33.5	608
35	23.0	4.9	14.3	6.4	48.6	1.4	3.1	4.3	9.4	1.4	19.6	0.9	1.5	4.1	4.0	1.6	1.1	3.1	15.5	31.8	652
36	23.9	4.9	14.7	6.3	49.8	1.2	2.9	5.5	8.8	1.3	19.7	0.9	1.6	3.9	3.5	1.6	1.0	2.9	15.1	30.5	693
37	24.3	4.9	15.3	6.2	50.7	1.1	2.8	6.9	8.3	1.3	20.4	0.8	1.8	3.6	3.1	1.5	0.9	2.6	14.6	28.9	739
38	25.3	4.9	15.4	6.0	51.6	1.0	2.7	8.6	7.8	1.3	21.4	0.8	2.0	3.2	2.8	1.4	0.8	2.3	13.7	27.0	783
39	26.2	4.9	15.9	5.9	52.9	0.9	2.5	10.2	7.2	1.5	22.3	0.7	2.2	3.0	2.4	1.3	0.7	2.0	12.5	24.8	830
40	26.9	4.9	16.2	5.7	53.7	0.8	2.5	11.7	6.8	1.6	23.4	0.7	2.3	2.7	2.2	1.2	0.7	1.6	11.5	22.9	879
41	26.9	5.0	16.4	5.5	53.8	0.8	2.4	13.6	6.4	1.8	25.0	0.6	2.5	2.6	1.9	1.2	0.6	1.3	10.5	21.2	929
42	27.2	5.1	16.7	5.3	54.3	0.7	2.4	15.2	6.0	2.2	26.5	0.6	2.7	2.4	1.6	1.1	0.6	0.9	9.3	19.2	977

TABLE 26 —*Grades sawed from 16′ butt logs of mature trees of different diameters breasthigh, expressed in per cent of total sawed out.*

(Values in this table obtained as indicated by $\frac{100a_1'}{A_1'} + \frac{100b_1'}{A_1'}$ + etc. Curves Ap_1', Bp_1' and Cp_1' shown in Figs. 142, 143 and 144.)

Diameter breasthigh in inches	HIGH GRADES					INTERMEDIATE GRADES						LOW GRADES									Total sawed out, all grades
	C. & Bet. 6/4	Mldg. Stock	No. 1 Shop 6/4	D. Sel. & Bet. 1″	Total	No. 1 Com. 1″	No. 2 Com. 1″	Shop 1″	No. 2 Shop 6/4	Shims	Total	Box 1″	Cull 2″	Box 6/4	No. 3 Shop 6/4	No. 3 Com. 1″	Plank 3″	4x4 & Lgr.	2x4 & wider No. 1 Dim.	Total	
	$\frac{100a_1'}{A'_1}+$	$\frac{100b_1'}{A'_1}+$	$\frac{100c_1'}{A'_1}+$	$\frac{100d_1'}{A'_1}$	$=Ap_1'$	$\frac{100e_1'}{A'_1}+$	$\frac{100f_1'}{A'_1}+$	$\frac{100g_1'}{A'_1}+$	$\frac{100h_1'}{A'_1}+$	$\frac{100i_1'}{A'_1}$	$=Bp_1'$	$\frac{100j_1'}{A'_1}+$	$\frac{100k_1'}{A'_1}+$	$\frac{100l_1'}{A'_1}+$	$\frac{100m_1'}{A'_1}+$	$\frac{100n_1'}{A'_1}+$	$\frac{100o_1'}{A'_1}+$	$\frac{100p_1'}{A'_1}+$	$\frac{100q_1'}{A'_1}$	$=Cp_1'$	A'_1
20	0.0	6.2	7.7	4.8	18.7	3.4	5.3	1.9	4.8	1.9	17.3	4.3	3.3	20.1	8.6	4.8	0.0	1.4	21.5	64.0	209
21	4.7	6.0	7.7	5.6	24.0	3.0	4.7	2.1	4.7	1.7	16.2	3.8	3.0	17.5	7.7	4.3	0.0	1.3	22.2	59.8	234
22	8.1	6.2	7.7	6.2	28.2	2.3	4.2	1.9	4.6	1.5	14.5	3.5	2.7	15.8	6.9	3.8	0.0	1.5	23.1	57.3	260
23	11.5	5.9	8.0	6.3	31.7	2.1	3.9	2.1	4.6	1.4	14.1	3.1	2.5	14.0	6.3	3.5	0.0	1.4	23.4	54.2	286
24	14.7	5.7	8.3	6.7	35.4	1.9	3.4	1.9	4.8	1.3	13.3	2.9	2.2	12.4	5.7	3.2	0.0	1.6	23.3	51.3	314
25	16.3	5.8	8.4	7.0	37.5	1.5	3.2	2.0	4.9	1.5	13.1	2.6	2.0	11.4	5.5	2.9	0.0	1.7	23.3	49.4	344
26	18.2	5.6	8.6	7.2	39.6	1.3	3.0	2.1	5.3	1.3	13.0	2.4	2.1	10.2	5.1	2.7	0.0	1.9	23.0	47.4	374
27	19.9	5.4	8.8	7.3	41.4	1.2	2.7	2.2	5.6	1.2	12.9	2.2	2.0	9.3	4.9	2.7	0.0	2.0	22.6	45.7	405
28	21.9	5.2	9.1	7.3	43.5	1.1	2.5	2.3	5.9	1.1	12.9	2.1	1.8	8.4	4.6	2.5	0.0	2.1	22.1	43.6	439
29	23.2	5.1	9.2	7.3	44.8	0.9	2.3	2.3	6.4	1.3	13.2	1.9	1.9	7.7	4.3	2.3	0.0	2.1	21.8	42.0	469
30	24.4	5.0	9.4	7.2	46.0	0.8	2.2	2.6	6.8	1.2	13.6	1.8	1.8	7.0	4.0	2.2	0.0	2.2	21.4	40.4	500
31	25.6	5.1	9.5	7.1	47.3	0.7	2.1	3.2	7.1	1.1	14.2	1.7	1.7	6.4	3.9	2.1	0.0	2.2	20.5	38.5	535
32	26.2	4.9	9.8	7.1	48.0	0.7	1.9	3.8	7.5	1.2	15.1	1.6	1.7	5.7	3.7	1.9	0.0	2.6	19.7	36.9	575
33	26.8	4.8	10.2	6.9	48.7	0.6	1.8	4.7	7.7	1.1	16.9	1.5	1.6	5.2	3.7	1.8	0.0	2.9	18.7	35.4	620
34	27.2	4.8	10.5	6.8	49.3	0.6	1.7	5.4	8.2	1.1	17.0	1.4	1.5	4.6	3.6	1.7	0.0	3.2	17.7	33.7	662
39	27.5	4.8	11.1	6.7	50.1	0.5	1.6	6.2	8.1	1.1	17.5	1.3	1.4	4.3	3.7	1.7	0.0	3.4	16.6	32.4	705
38	27.9	4.8	11.3	6.5	50.5	0.4	1.5	7.0	8.4	1.2	18.5	1.2	1.3	3.9	3.9	1.6	0.0	3.7	15.4	31.0	752
37	28.0	4.7	11.8	6.4	50.9	0.4	1.4	8.0	8.6	1.1	19.5	1.1	1.4	3.6	3.9	1.5	0.0	4.0	14.1	29.6	800
36	28.3	4.7	12.1	6.3	51.4	0.4	1.3	8.9	8.7	1.2	20.5	1.0	1.3	3.3	3.9	1.4	0.0	4.3	12.9	28.1	844
35	28.4	4.8	12.8	6.2	52.2	0.3	1.2	9.9	9.0	1.1	21.5	1.0	1.2	3.1	4.0	1.3	0.0	4.4	11.3	26.3	893
40	28.5	4.9	13.5	6.0	52.9	0.3	1.3	10.6	9.0	1.2	22.4	0.9	1.3	2.8	4.0	1.4	0.0	4.5	9.8	24.7	946
41	28.5	4.9	14.5	5.8	53.7	0.3	1.2	11.4	9.2	1.1	23.2	0.9	1.3	2.6	4.0	1.3	0.0	4.7	8.3	23.1	996
42	28.7	4.9	15.4	5.6	54.6	0.3	1.2	12.2	9.2	1.1	24.0	0.9	1.4	2.4	4.0	1.2	0.0	4.8	6.7	21.4	1052
43	28.7	4.9	16.5	5.4	55.5	0.3	1.2	12.8	9.3	1.1	24.7	0.8	1.6	2.1	4.0	1.2	0.0	5.0	5.1	19.8	1137
44	28.6	5.0	17.4	5.1	56.1	0.3	1.2	13.4	9.3	1.1	25.3	0.8	1.8	1.9	4.1	1.1	0.0	5.2	3.7	18.6	1182

TABLE 27.—*Value of grades sawed from 16′ butt logs of immature trees of different diameters breasthigh, expressed in dollars and cents.* (Values in this table obtained as indicated by .032*a*′ + .030*b*′ + etc. Curves Aval′, Bval′ and Cval′ shown in Figs. 145, 146 and 147.)

Diameter breasthigh in inches	HIGH GRADES					INTERMEDIATE GRADES						LOW GRADES									Value per butt log
	C. & Bet. 6/4	Mldg. Stock	No. 1 Shop 6/4	D. Sel. & Bet. 1″	Total	No. 1 Com. 1″	No. 2 Com. 1″	Shop 1″	No. 2 Shop 6/4	Shims	Total	Box 1″	Cull 2″	Box 6/4	No. 3 Shop 6/4	No. 3 Com. 1″	Plank 3″	4x4 & Lgr.	2x4 & wider No. 1 Dim.	Total	
	.032a′ + .030b′ + .027c′ + .025d′ = Aval′					.022e′ + .018f′ + .018g′ + .018h′ + .007i′ = Bval′						.009j′ + .007k′ + .011l′ + .013m′ + .015n′ + .015o′ + .015p′ + .015q′ = Cval′									B′
20	.10	.27	.11	.17	.65	.22	.20	.13	.13	.02	.70	.12	.03	.38	.23	.13	.10	.16	.75	1.90	3.25
21	.16	.30	.13	.25	.84	.22	.22	.13	.23	.02	.82	.11	.03	.37	.30	.13	.10	.16	.78	1.98	3.64
22	.26	.33	.16	.30	1.05	.22	.22	.13	.36	.03	.96	.10	.03	.37	.35	.13	.10	.16	.81	2.05	4.06
23	.38	.36	.22	.37	1.33	.22	.23	.13	.49	.03	1.10	.09	.03	.36	.36	.13	.10	.16	.85	2.08	4.51
24	.54	.39	.32	.45	1.70	.22	.23	.13	.58	.03	1.19	.09	.03	.36	.40	.13	.10	.18	.90	2.19	5.08
25	.77	.45	.43	.50	2.15	.22	.25	.14	.67	.03	1.31	.08	.03	.35	.42	.13	.10	.18	.93	2.22	5.68
26	.99	.48	.57	.55	2.59	.22	.27	.14	.74	.03	1.40	.08	.03	.35	.43	.13	.10	.18	.98	2.28	6.27
27	1.31	.54	.76	.62	3.23	.22	.27	.16	.83	.04	1.52	.07	.03	.34	.44	.15	.10	.18	1.02	2.33	7.08
28	1.60	.60	.95	.70	3.85	.22	.29	.16	.90	.04	1.61	.07	.03	.33	.44	.15	.10	.19	1.05	2.36	7.82
29	1.98	.63	1.11	.75	4.47	.22	.31	.18	.97	.05	1.73	.06	.03	.33	.43	.15	.10	.21	1.08	2.39	8.59
30	2.43	.66	1.35	.80	5.24	.22	.31	.18	1.01	.05	1.77	.06	.03	.33	.43	.15	.10	.24	1.14	2.48	9.49
31	2.82	.72	1.54	.87	5.95	.20	.32	.18	1.05	.05	1.80	.06	.04	.32	.42	.15	.10	.26	1.23	2.58	10.33
32	3.23	.78	1.76	.92	6.69	.20	.32	.20	1.07	.06	1.85	.05	.05	.32	.40	.15	.10	.27	1.27	2.61	11.15
33	3.65	.84	2.02	.97	7.48	.20	.34	.25	1.08	.06	1.93	.05	.06	.31	.39	.15	.10	.30	1.35	2.71	12.12
34	4.22	.90	2.27	1.02	8.41	.20	.36	.36	1.08	.06	2.06	.05	.06	.31	.36	.15	.10	.30	1.44	2.77	13.24
35	4.80	.96	2.51	1.05	9.32	.20	.36	.50	1.10	.06	2.22	.05	.07	.30	.34	.16	.10	.30	1.51	2.83	14.37
36	5.31	1.02	2.85	1.10	10.28	.18	.36	.68	1.10	.06	2.38	.05	.08	.30	.31	.16	.10	.30	1.57	2.87	15.53
37	5.83	1.08	3.05	1.12	11.08	.18	.38	.92	1.10	.06	2.64	.05	.09	.29	.30	.16	.10	.28	1.62	2.89	16.61
38	6.33	1.17	3.26	1.18	11.94	.18	.38	1.21	1.10	.07	2.94	.05	.11	.27	.28	.16	.09	.27	1.61	2.84	17.72
39	6.95	1.23	3.56	1.23	12.97	.15	.38	1.53	1.08	.08	3.22	.05	.13	.27	.26	.16	.09	.24	1.56	2.76	18.95
40	7.55	1.29	3.84	1.25	13.93	.15	.40	1.86	1.08	.10	3.59	.05	.14	.26	.25	.16	.09	.21	1.52	2.68	20.20
41	8.00	1.38	4.13	1.27	14.78	.15	.40	2.27	1.08	.12	4.02	.05	.16	.26	.23	.16	.09	.18	1.46	2.59	21.39
42	8.51	1.50	4.40	1.30	15.71	.15	.42	2.66	1.06	.15	4.44	.05	.18	.25	.21	.16	.09	.14	1.36	2.44	22.59

TABLE 28.—*Value of grades sawed from 16′ butt logs of mature trees of different diameters breasthigh, expressed in dollars and cents.* (Values in this table obtained as indicated by $.032a_1' + .030b_1'$ + etc. Curves Aval$_1'$, Bval$_1'$ and Cval$_1'$ shown in Figs. 148, 149 and 150.)

Diameter breasthigh in inches	HIGH GRADES					INTERMEDIATE GRADES						LOW GRADES									Value per butt log
	C. & Bet. 6/4	Mldg. Stock	No. 1 Shop 6/4	D. Sel. & Bet. 1″	Total	No. 1 Com. 1″	No. 2 Com. 1″	Shop 1″	No. 2 Shop 6/4	Shims	Total	Box 1″	Cull 2″	Box 6/4	No. 3 Shop 6/4	No. 3 Com. 1″	Plank 3″	4x4 & Lgr.	2x4 & wider No. 1 Dim.	Total	
	$.032a_1'$	$+.030b_1'$	$+.027c_1'$	$+.025d_1'$	$=\text{Aval}_1'$	$.022e_1'$	$+.018f_1'$	$+.018g_1'$	$+.018h_1'$	$+.007i_1'$	$=\text{Bval}_1'$	$.009j_1'$	$+.007k_1'$	$+.011l_1'$	$+.013m_1'$	$+.015n_1'$	$+.015o_1'$	$+.015p_1'$	$+.015q_1'$	$=\text{Cval}_1'$	B_1'
20	.00	.39	.43	.25	1.07	.15	.20	.07	.18	.03	.63	.08	.05	.46	.23	.15	.00	.05	.68	1.70	3.40
21	.35	.42	.49	.33	1.59	.15	.20	.09	.20	.03	.67	.08	.05	.45	.23	.15	.00	.05	.78	1.79	4.05
22	.67	.48	.54	.40	2.09	.13	.20	.09	.22	.03	.67	.08	.05	.45	.23	.15	.00	.06	.90	1.92	4.68
23	1.06	.51	.62	.45	2.64	.13	.20	.11	.23	.03	.70	.08	.05	.44	.23	.15	.00	.06	1.01	2.02	5.36
24	1.47	.54	.70	.52	3.23	.13	.20	.11	.27	.03	.74	.08	.05	.43	.23	.15	.00	.07	1.10	2.11	6.08
25	1.80	.60	.78	.60	3.78	.11	.20	.13	.31	.04	.79	.08	.05	.43	.25	.15	.00	.09	1.20	2.25	6.82
26	2.18	.63	.87	.68	4.36	.11	.20	.14	.36	.04	.85	.08	.06	.42	.25	.15	.00	.11	1.29	2.36	7.57
27	2.59	.66	.97	.75	4.97	.11	.20	.16	.42	.04	.93	.08	.06	.42	.26	.17	.00	.12	1.37	2.48	8.38
28	3.04	.69	1.08	.80	5.61	.11	.20	.18	.47	.04	1.00	.08	.06	.41	.26	.17	.00	.14	1.46	2.58	9.19
29	3.49	.72	1.16	.85	6.22	.09	.20	.20	.54	.04	1.07	.08	.06	.40	.26	.17	.00	.15	1.53	2.65	9.94
30	3.94	.75	1.27	.90	6.86	.09	.20	.23	.61	.04	1.17	.08	.06	.39	.26	.17	.00	.17	1.60	2.73	10.76
31	4.38	.81	1.38	.95	7.52	.09	.20	.31	.69	.04	1.33	.08	.06	.37	.27	.17	.00	.18	1.65	2.78	11.63
32	4.83	.84	1.51	1.02	8.20	.09	.20	.40	.78	.05	1.52	.08	.07	.36	.27	.17	.00	.22	1.70	2.87	12.59
33	5.32	.90	1.70	1.08	9.00	.09	.20	.52	.87	.05	1.73	.08	.07	.35	.30	.17	.00	.27	1.74	2.98	13.71
34	5.76	.96	1.89	1.13	9.74	.09	.20	.65	.97	.05	1.96	.08	.07	.34	.31	.17	.00	.32	1.76	3.05	14.75
35	6.24	1.02	2.11	1.18	10.55	.07	.20	.79	1.03	.06	2.15	.08	.07	.33	.34	.18	.00	.36	1.76	3.12	15.82
36	6.72	1.08	2.30	1.22	11.32	.07	.20	.96	1.14	.06	2.43	.08	.07	.32	.38	.18	.00	.42	1.74	3.19	16.94
37	7.17	1.14	2.54	1.27	12.12	.07	.20	1.15	1.24	.06	2.72	.08	.08	.32	.40	.18	.00	.48	1.70	3.24	18.08
38	7.65	1.20	2.76	1.33	12.94	.07	.20	1.35	1.32	.07	3.01	.08	.08	.31	.43	.18	.00	.54	1.64	3.26	19.21
39	8.10	1.29	3.08	1.38	13.85	.07	.20	1.58	1.44	.07	3.36	.08	.08	.31	.47	.18	.00	.58	1.52	3.22	20.43
40	8.62	1.38	3.46	1.43	14.89	.07	.22	1.80	1.53	.08	3.70	.08	.08	.30	.50	.20	.00	.65	1.40	3.21	21.80
41	9.10	1.47	3.89	1.45	15.91	.07	.22	2.04	1.64	.08	4.05	.08	.09	.29	.52	.20	.00	.70	1.25	3.13	23.09
42	9.64	1.56	4.37	1.48	17.05	.07	.23	2.30	1.75	.08	4.43	.08	.11	.28	.55	.20	.00	.77	1.05	3.04	24.52
43	10.25	1.65	4.97	1.50	18.37	.07	.25	2.58	1.87	.08	4.85	.08	.13	.26	.59	.20	.00	.84	.86	2.96	26.18
44	10.83	1.77	5.57	1.50	19.67	.07	.25	2.86	1.98	.09	5.25	.08	.15	.25	.63	.20	.00	.93	.66	2.90	27.82

AVERAGE VALUES FOR TOP LOGS.

TABLE 29.—*Volume in board feet of each grade sawed out at mill from top logs of immature western yellow pine trees of different diameters breasthigh.*

(Values read from curves shown on left-hand pages Nos. 106 to 116, inclusive.)

Diameter breasthigh in inches	HIGH GRADES					INTERMEDIATE GRADES						LOW GRADES									Total sawed out, all grades
	C. & Bet. 6/4	Mldg. Stock	No. 1 Shop 6/4	D. Sel. & Bet. 1″	Total	No. 1 Com. 1″	No. 2 Com. 1″	Shop 1″	No. 2 Shop 6/4	Shims	Total	Box 1″	Cull 2″	Box 6/4	No. 3 Shop 6/4	No. 3 Com. 1″	Plank 3″	4x4 & Lgr.	2x4 & wider No. 1 Dim.	Total	
	a″ +	b″ +	c″ +	d″ =	Av″	e″ +	f″ +	g″ +	h″ +	i″ =	Bv″	j″ +	k″ +	l″ +	m″ +	n″ +	o″ +	p″ +	q″ =	Cv″	A″
20	0	0	0	0	0	0	4	0	0	0	4	11	0	4	0	4	0	7	16	42	46
21	0	0	0	0	0	0	4	0	0	0	4	11	0	4	0	4	0	7	16	42	46
22	0	0	0	0	0	0	4	0	0	0	4	12	0	4	0	4	0	7	17	44	48
23	0	0	0	0	0	0	4	0	0	0	4	12	0	4	0	4	0	8	17	45	49
24	0	0	0	0	0	0	4	0	0	0	4	12	0	4	0	4	0	8	18	46	50
25	0	0	0	0	0	0	4	0	0	0	4	13	0	5	0	4	0	8	19	49	53
26	0	0	0	0	0	0	4	0	0	0	4	13	0	5	0	4	0	8	20	50	54
27	0	0	0	0	0	0	4	0	0	0	4	13	0	5	0	4	0	9	20	51	55
28	0	0	0	0	0	0	4	0	0	0	4	13	0	6	0	4	0	9	21	53	57
29	0	0	0	0	0	0	4	0	0	0	4	14	0	6	0	4	0	9	22	55	59
30	0	0	0	0	0	0	4	0	0	0	4	14	0	7	0	4	0	9	22	56	60
31	0	0	0	0	0	0	4	0	0	0	4	14	0	7	0	4	0	10	23	58	62
32	0	0	0	0	0	0	4	0	0	0	4	14	0	7	0	4	0	10	24	59	63
33	0	0	0	0	0	0	3	0	0	0	3	15	0	8	0	4	0	10	25	62	65
34	0	0	0	0	0	0	3	0	0	0	3	15	0	9	0	4	0	10	26	64	67
35	0	0	0	0	0	0	3	0	0	0	3	15	0	10	0	4	0	10	27	66	69
36	0	0	0	0	0	0	3	0	0	0	3	16	0	12	0	4	0	11	27	70	73
37	0	0	0	0	0	0	3	0	0	0	3	17	0	14	0	3	0	11	28	73	76
38	0	0	0	0	0	0	3	0	0	0	3	18	0	16	0	3	0	11	28	76	79
39	0	0	0	0	0	0	3	0	0	0	3	19	0	18	0	3	0	11	29	80	83
40	0	0	0	0	0	0	3	0	0	0	3	20	0	20	0	3	0	11	30	84	87
41	0	0	0	0	0	0	3	0	0	0	3	22	0	23	0	3	0	12	31	91	94
42	0	0	0	0	0	0	3	0	0	0	3	24	0	27	0	3	0	12	32	98	101

TABLE 30.—*Volume in board feet of each grade sawed out at mill from top logs of mature western yellow pine trees of different diameters breasthigh.*

(Values read from curves shown on right-hand pages Nos. 107 to 117, inclusive.)

Diameter breasthigh in inches	HIGH GRADES					INTERMEDIATE GRADES						LOW GRADES									Total sawed out, all grades
	C. & Bet. 6/4	Mldg. Stock	No. 1 Shop 6/4	D. Sel. & Bet. 1″	Total	No. 1 Com. 1″	No. 2 Com. 1″	Shop 1″	No. 2 Shop 6/4	Shims	Total	Box 1″	Cull 2″	Box 6/4	No. 3 Shop 6/4	No. 3 Com. 1″	Plank 3″	4x4 & Lgr.	2x4 & wider No. 1 Dim.	Total	
	a_1'' +	b_1'' +	c_1'' +	d_1''	$= Av_1''$	e_1'' +	f_1'' +	g_1'' +	h_1'' +	i_1''	$= Bv_1''$	j_1'' +	k_1'' +	l_1'' +	m_1'' +	n_1'' +	o_1'' +	p_1'' +	q_1''	$= Cv_1''$	A_1''
20	0	0	0	0	0	0	4	0	0	0	4	12	0	5	2	5	0	11	32	67	71
21	0	0	0	0	0	0	4	0	0	0	4	12	0	6	2	5	0	11	32	68	72
22	0	0	0	0	0	0	4	0	0	0	4	13	0	6	2	5	0	11	33	70	74
23	0	0	0	0	0	0	4	0	0	0	4	13	0	7	3	5	0	11	33	72	76
24	0	0	0	0	0	0	4	0	0	0	4	14	0	7	3	5	0	11	33	73	77
25	0	0	0	0	0	0	4	0	0	0	4	14	0	8	3	5	0	11	34	75	79
26	0	0	0	0	0	0	4	0	0	0	4	15	0	8	3	5	0	11	34	76	80
27	0	0	0	0	0	0	4	0	0	0	4	15	0	9	4	5	0	11	34	78	82
28	0	0	0	0	0	0	4	0	0	0	4	16	0	9	4	5	0	11	35	80	84
29	0	0	0	0	0	0	4	0	0	0	4	17	0	10	4	5	0	11	35	82	86
30	0	0	0	0	0	0	4	0	2	0	6	18	0	10	5	5	0	11	35	84	90
31	0	0	0	0	0	0	4	0	2	0	6	18	0	11	5	5	0	11	36	86	92
32	0	0	0	0	0	0	4	0	2	0	6	19	0	12	5	5	0	11	36	88	94
33	0	0	0	0	0	0	3	0	2	0	5	20	0	13	5	5	0	11	36	90	95
34	0	0	0	0	0	0	3	0	3	0	6	21	0	14	6	5	0	11	36	93	99
35	0	0	0	0	0	0	3	0	3	0	6	22	0	15	6	5	0	12	37	97	103
36	0	0	0	0	0	0	3	0	3	0	6	24	0	16	6	5	0	12	37	100	106
37	0	0	0	0	0	0	3	0	4	0	7	26	0	18	6	5	0	12	37	104	111
38	0	0	0	0	0	0	3	0	5	0	8	28	0	20	7	5	0	12	37	109	117
39	0	0	0	0	0	0	3	0	6	0	9	30	0	23	7	5	0	12	38	115	124
40	0	0	0	0	0	0	3	0	7	0	10	32	0	25	7	5	0	12	38	119	129
41	0	0	0	0	0	0	3	0	8	0	11	35	0	28	7	5	0	12	38	125	136
42	0	0	0	0	0	0	3	0	9	0	12	38	0	31	8	5	0	12	38	132	144
43	0	0	0	0	0	0	3	0	9	0	12	41	0	35	8	5	0	12	39	140	152
44	0	0	0	0	0	0	3	0	10	0	13	45	0	39	8	5	0	12	39	148	161

TABLE 31.—*Grades sawed from top logs of immature trees of different diameters breasthigh, expressed in per cent of total sawed out.*

(Values in this table obtained as indicated by $\frac{100a''}{A''} + \frac{100b''}{A''} + \text{etc.}$)

Diameter breasthigh in inches	HIGH GRADES					INTERMEDIATE GRADES						LOW GRADES									Total sawed out, all grades
	C. & Bet. 6/4	Mldg. Stock	No. 1 Shop 6/4	D. Sel. & Bet. 1"	Total	No. 1 Com. 1"	No. 2 Com. 1"	Shop 1"	No. 2 Shop 6/4	Shims	Total	Box 1"	Cull 2"	Box 6/4	No. 3 Shop 6/4	No. 3 Com. 1"	Plank 3"	4x4 & Lgr.	2x4 & wider No. 1 Dim.	Total	
	$\frac{100a''}{A''}$ +	$\frac{100b''}{A''}$ +	$\frac{100c''}{A''}$ +	$\frac{100d''}{A''}$ =	Ap"	$\frac{100e''}{A''}$ +	$\frac{100f''}{A''}$ +	$\frac{100g''}{A''}$ +	$\frac{100h''}{A''}$ +	$\frac{100i''}{A''}$ =	Bp"	$\frac{100j''}{A''}$ +	$\frac{100k''}{A''}$ +	$\frac{100l''}{A''}$ +	$\frac{100m''}{A''}$ +	$\frac{100n''}{A''}$ +	$\frac{100o''}{A''}$ +	$\frac{100p''}{A''}$ +	$\frac{100q''}{A''}$ =	Cp"	A"
20	0.0	0.0	0.0	0.0	0.0	0.0	8.7	0.0	0.0	0.0	8.7	23.9	0.0	8.7	0.0	8.7	0.0	15.2	34.8	91.3	46
21	0.0	0.0	0.0	0.0	0.0	0.0	8.7	0.0	0.0	0.0	8.7	23.9	0.0	8.7	0.0	8.7	0.0	15.2	34.8	91.3	46
22	0.0	0.0	0.0	0.0	0.0	0.0	8.3	0.0	0.0	0.0	8.3	25.0	0.0	8.3	0.0	8.3	0.0	14.6	35.5	91.7	48
23	0.0	0.0	0.0	0.0	0.0	0.0	8.2	0.0	0.0	0.0	8.2	24.5	0.0	8.1	0.0	8.2	0.0	16.3	34.7	91.8	49
24	0.0	0.0	0.0	0.0	0.0	0.0	8.0	0.0	0.0	0.0	8.0	24.0	0.0	8.0	0.0	8.0	0.0	16.0	36.0	92.0	50
25	0.0	0.0	0.0	0.0	0.0	0.0	7.6	0.0	0.0	0.0	7.6	24.5	0.0	9.4	0.0	7.6	0.0	15.1	35.8	92.4	53
26	0.0	0.	0.0	0.0	0.0	0.0	7.4	0.0	0.0	0.0	7.4	24.1	0.0	9.3	0.0	7.4	0.0	14.8	37.0	92.6	54
27	0.0	0.0	0.0	0.0	0.0	0.0	7.3	0.0	0.0	0.0	7.3	23.5	0.0	9.1	0.0	7.3	0.0	16.4	36.4	92.7	55
28	0.0	0.0	0.0	0.0	0.0	0.0	7.0	0.0	0.0	0.0	7.0	22.8	0.0	10.6	0.0	7.0	0.0	15.8	36.8	93.0	57
29	0.0	0.0	0.0	0.0	0.0	0.0	6.8	0.0	0.0	0.0	6.8	23.6	0.0	10.2	0.0	6.8	0.0	15.3	37.3	93.2	59
30	0.0	0.0	0.0	0.0	0.0	0.0	6.7	0.0	0.0	0.0	6.7	23.2	0.0	11.7	0.0	6.7	0.0	15.0	36.7	93.3	60
31	0.0	0.0	0.0	0.0	0.0	0.0	6.5	0.0	0.0	0.0	6.5	22.6	0.0	11.3	0.0	6.4	0.0	16.1	37.1	93.5	62
32	0.0	0.0	0.0	0.0	0.0	0.0	6.4	0.0	0.0	0.0	6.4	22.2	0.0	11.1	0.0	6.4	0.0	15.8	38.1	93.6	63
33	0.0	0.0	0.0	0.0	0.0	0.0	4.6	0.0	0.0	0.0	4.6	23.1	0.0	12.3	0.0	6.1	0.0	15.4	38.5	95.4	65
34	0.0	0.0	0.0	0.0	0.0	0.0	4.5	0.0	0.0	0.0	4.5	22.3	0.0	13.5	0.0	6.0	0.0	14.9	38.8	95.5	67
35	0.0	0.0	0.0	0.0	0.0	0.0	4.4	0.0	0.0	0.0	4.4	21.7	0.0	14.5	0.0	5.8	0.0	14.5	39.1	95.6	69
36	0.0	0.0	0.0	0.0	0.0	0.0	4.1	0.0	0.0	0.0	4.1	21.9	0.0	16.4	0.0	5.5	0.0	15.1	37.0	95.9	73
37	0.0	0.0	0.0	0.0	0.0	0.0	4.0	0.0	0.0	0.0	4.0	22.4	0.0	18.4	0.0	3.9	0.0	14.5	36.8	96.0	76
38	0.0	0.0	0.0	0.0	0.0	0.0	3.8	0.0	0.0	0.0	3.8	22.8	0.0	20.2	0.0	3.9	0.0	13.9	35.4	96.2	79
39	0.0	0.0	0.0	0.0	0.0	0.0	3.6	0.0	0.0	0.0	3.6	22.9	0.0	21.7	0.0	3.6	0.0	13.2	35.0	96.4	83
40	0.0	0.0	0.0	0.0	0.0	0.0	3.5	0.0	0.0	0.0	3.5	23.0	0.0	23.0	0.0	3.4	0.0	12.6	34.5	96.5	87
41	0.0	0.0	0.0	0.0	0.0	0.0	3.2	0.0	0.0	0.0	3.2	23.4	0.0	24.4	0.0	3.2	0.0	12.8	33.0	96.8	94
42	0.0	0.0	0.0	0.0	0.0	0.0	3.0	0.0	0.0	0.0	3.0	23.8	0.0	26.7	0.0	3.0	0.0	11.9	31.6	97.0	101

TABLE 32.—*Grades sawed from top logs of mature trees of different diameters breasthigh, expressed in per cent of total sawed out.*

(Values in this table obtained as indicated by $\frac{100a_1''}{A_1''} + \frac{100b_1''}{A_1''} + \text{etc.}$)

Diameter breasthigh in inches	HIGH GRADES					INTERMEDIATE GRADES						LOW GRADES									Total sawed out, all grades
	C. & Bet. 6/4	Mldg. Stock	No. 1 Shop 6/4	D. Sel. & Bet. 1″	Total	No. 1 Com. 1″	No. 2 Com. 1″	Shop 1″	No. 2 Shop 6/4	Shims	Total	Box 1″	Cull 2″	Box 6/4	No. 3 Shop 6/4	No. 3 Com. 1″	Plank 3″	4x4 & Lgr.	2x4 & wider No. 1 Dim.	Total	
	$\frac{100a_1''}{A_1''}+$	$\frac{100b_1''}{A_1''}+$	$\frac{100c_1''}{A_1''}+$	$\frac{100d_1''}{A_1''}$	$= Ap_1''$	$\frac{100e_1''}{A_1''}+$	$\frac{100f_1''}{A_1''}+$	$\frac{100g_1''}{A_1''}+$	$\frac{100h_1''}{A_1''}+$	$\frac{100i_1''}{A_1''}$	$= Bp_1''$	$\frac{100j_1''}{A_1''}+$	$\frac{100k_1''}{A_1''}+$	$\frac{100l_1''}{A_1''}+$	$\frac{100m_1''}{A_1''}+$	$\frac{100n_1''}{A_1''}+$	$\frac{100o_1''}{A_1''}+$	$\frac{100p_1''}{A_1''}+$	$\frac{100q_1''}{A_1''}$	$= Cp_1''$	A_1''
20	0.0	0.0	0.0	0.0	0.0	0.0	5.6	0.0	0.0	0.0	5.6	16.9	0.0	7.0	2.8	7.1	0.0	15.5	45.1	94.4	71
21	0.0	0.0	0.0	0.0	0.0	0.0	5.6	0.0	0.0	0.0	5.6	16.6	0.0	8.3	2.8	7.0	0.0	15.3	44.4	94.4	72
22	0.0	0.0	0.0	0.0	0.0	0.0	5.4	0.0	0.0	0.0	5.4	17.6	0.0	8.1	2.7	6.8	0.0	14.8	44.6	94.6	74
23	0.0	0.0	0.0	0.0	0.0	0.0	5.3	0.0	0.0	0.0	5.3	17.1	0.0	9.2	3.9	6.6	0.0	14.5	43.4	94.7	76
24	0.0	0.0	0.0	0.0	0.0	0.0	5.2	0.0	0.0	0.0	5.2	18.2	0.0	9.1	3.9	6.5	0.0	14.3	42.8	94.8	77
25	0.0	0.0	0.0	0.0	0.0	0.0	5.1	0.0	0.0	0.0	5.1	17.7	0.0	10.1	3.8	6.4	0.0	13.9	43.0	94.9	79
26	0.0	0.0	0.0	0.0	0.0	0.0	5.0	0.0	0.0	0.0	5.0	18.7	0.0	10.0	3.8	6.3	0.0	13.7	42.5	95.0	80
27	0.0	0.0	0.0	0.0	0.0	0.0	4.9	0.0	0.0	0.0	4.9	18.3	0.0	11.0	4.9	6.1	0.0	13.4	41.4	95.1	82
28	0.0	0.0	0.0	0.0	0.0	0.0	4.8	0.0	0.0	0.0	4.8	19.0	0.0	10.7	4.8	5.9	0.0	13.1	41.7	95.2	84
29	0.0	0.0	0.0	0.0	0.0	0.0	4.7	0.0	0.0	0.0	4.7	19.7	0.0	11.6	4.7	5.8	0.0	12.8	40.7	95.3	86
30	0.0	0.0	0.0	0.0	0.0	0.0	4.4	0.0	2.2	0.0	6.6	20.0	0.0	11.1	5.6	5.6	0.0	12.2	38.9	93.4	90
31	0.0	0.0	0.0	0.0	0.0	0.0	4.3	0.0	2.1	0.0	6.4	19.6	0.0	12.0	5.4	5.4	0.0	12.0	39.2	93.7	92
32	0.0	0.0	0.0	0.0	0.0	0.0	4.3	0.0	2.1	0.0	6.4	20.2	0.0	12.8	5.3	5.3	0.0	11.7	38.3	93.6	94
33	0.0	0.0	0.0	0.0	0.0	0.0	3.2	0.0	2.1	0.0	5.3	21.0	0.0	13.6	5.3	5.3	0.0	11.6	37.9	94.7	95
34	0.0	0.0	0.0	0.0	0.0	0.0	3.0	0.0	3.0	0.0	6.0	21.2	0.0	14.1	6.1	5.1	0.0	11.1	36.4	94.0	99
35	0.0	0.0	0.0	0.0	0.0	0.0	2.9	0.0	2.9	0.0	5.8	21.4	0.0	14.6	5.8	4.9	0.0	11.6	35.9	94.2	103
36	0.0	0.0	0.0	0.0	0.0	0.0	2.8	0.0	2.8	0.0	5.6	22.6	0.0	15.2	5.7	4.7	0.0	11.3	34.9	94.3	106
37	0.0	0.0	0.0	0.0	0.0	0.0	2.7	0.0	3.6	0.0	6.3	23.4	0.0	16.2	5.5	4.5	0.0	10.8	33.3	93.7	111
38	0.0	0.0	0.0	0.0	0.0	0.0	2.6	0.0	4.3	0.0	6.9	23.9	0.0	17.1	5.9	4.3	0.0	10.3	31.6	93.1	117
39	0.0	0.0	0.0	0.0	0.0	0.0	2.4	0.0	4.8	0.0	7.2	24.2	0.0	18.6	5.7	4.0	0.0	9.7	30.6	92.8	124
40	0.0	0.0	0.0	0.0	0.0	0.0	2.3	0.0	5.4	0.0	7.7	24.8	0.0	19.5	5.4	3.9	0.0	9.3	29.4	92.3	129
41	0.0	0.0	0.0	0.0	0.0	0.0	2.2	0.0	5.9	0.0	8.1	25.7	0.0	20.6	5.2	3.7	0.0	8.8	27.9	91.9	136
42	0.0	0.0	0.0	0.0	0.0	0.0	2.1	0.0	6.2	0.0	8.3	26.4	0.0	21.5	5.6	3.5	0.0	8.3	26.4	91.7	144
43	0.0	0.0	0.0	0.0	0.0	0.0	2.0	0.0	5.9	0.0	7.9	27.0	0.0	23.0	5.3	3.3	0.0	7.9	25.6	92.1	152
44	0.0	0.0	0.0	0.0	0.0	0.0	1.9	0.0	6.2	0.0	8.1	27.9	0.0	24.2	5.0	3.1	0.0	7.5	24.2	91.9	161

TABLE 33.—*Value of grades sawed from top logs of immature trees of different diameters breasthigh, expressed in dollars and cents.* (Values in this table obtained as indicated by $.032a'' + .030b''$ + etc. Curves Bval″ and Cval″ shown in Figs. 189 and 190.)

Diameter breasthigh in inches	HIGH GRADES					INTERMEDIATE GRADES						LOW GRADES									Value per top log
	C. & Bet. 6/4	Mldg. Stock	No. 1 Shop 6/4	D. Sel. & Bet. 1″	Total	No. 1 Com. 1″	No. 2 Com. 1″	Shop 1″	No. 2 Shop 6/4	Shims	Total	Box 1″	Cull 2″	Box 6/4	No. 3 Shop 6/4	No. 3 Com. 1″	Plank 3″	4x4 & Lgr.	2x4 & wider No. 1 Dim.	Total	
	$.032a''+.025b''+.027c''+.025d''=\text{Aval}''$					$.022e''+.018f''+.018g''+.018h''+.007i''=\text{Bval}''$						$.009j''+.007k''+.011l''+.013m''+.015n''+.015o''+.015p''+.015q''=\text{Cval}''$									B″
20	.00	.00	.00	.00	.00	.00	.07	.00	.00	.00	.07	.10	.00	.04	.00	.06	.00	.10	.24	.54	.61
21	.00	.00	.00	.00	.00	.00	.07	.00	.00	.00	.07	.10	.00	.04	.00	.06	.00	.10	.24	.54	.61
22	.00	.00	.00	.00	.00	.00	.07	.00	.00	.00	.07	.11	.00	.04	.00	.06	.00	.10	.26	.57	.64
23	.00	.00	.00	.00	.00	.00	.07	.00	.00	.00	.07	.11	.00	.04	.00	.06	.00	.12	.26	.59	.66
24	.00	.00	.00	.00	.00	.00	.07	.00	.00	.00	.07	.11	.00	.04	.00	.06	.00	.12	.27	.60	.67
25	.00	.00	.00	.00	.00	.00	.07	.00	.00	.00	.07	.12	.00	.05	.00	.06	.00	.12	.29	.64	.71
26	.00	.00	.00	.00	.00	.00	.07	.00	.00	.00	.07	.12	.00	.05	.00	.06	.00	.12	.30	.65	.72
27	.00	.00	.00	.00	.00	.00	.07	.00	.00	.00	.07	.12	.00	.05	.00	.06	.00	.14	.30	.67	.74
28	.00	.00	.00	.00	.00	.00	.07	.00	.00	.00	.07	.12	.00	.07	.00	.06	.00	.14	.32	.71	.78
29	.00	.00	.00	.00	.00	.00	.07	.00	.00	.00	.07	.13	.00	.07	.00	.06	.00	.14	.33	.73	.80
30	.00	.00	.00	.00	.00	.00	.07	.00	.00	.00	.07	.13	.00	.08	.00	.06	.00	.14	.33	.74	.81
31	.00	.00	.00	.00	.00	.00	.07	.00	.00	.00	.07	.13	.00	.08	.00	.06	.00	.15	.35	.77	.84
32	.00	.00	.00	.00	.00	.00	.07	.00	.00	.00	.07	.13	.00	.08	.00	.06	.00	.15	.36	.78	.85
33	.00	.00	.00	.00	.00	.00	.05	.00	.00	.00	.05	.14	.00	.09	.00	.06	.00	.15	.38	.82	.87
34	.00	.00	.00	.00	.00	.00	.05	.00	.00	.00	.05	.14	.00	.10	.00	.06	.00	.15	.39	.84	.89
35	.00	.00	.00	.00	.00	.00	.05	.00	.00	.00	.05	.14	.00	.11	.00	.06	.00	.15	.41	.87	.92
36	.00	.00	.00	.00	.00	.00	.05	.00	.00	.00	.05	.14	.00	.13	.00	.06	.00	.17	.41	.91	.96
37	.00	.00	.00	.00	.00	.00	.05	.00	.00	.00	.05	.15	.00	.15	.00	.04	.00	.17	.42	.93	.98
38	.00	.00	.00	.00	.00	.00	.05	.00	.00	.00	.05	.16	.00	.18	.00	.04	.00	.17	.42	.97	1.02
39	.00	.00	.00	.00	.00	.00	.05	.00	.00	.00	.05	.17	.00	.20	.00	.04	.00	.17	.44	1.02	1.07
40	.00	.00	.00	.00	.00	.00	.05	.00	.00	.00	.05	.18	.00	.22	.00	.04	.00	.17	.45	1.06	1.11
41	.00	.00	.00	.00	.00	.00	.05	.00	.00	.00	.05	.20	.00	.25	.00	.04	.00	.18	.47	1.14	1.19
42	.00	.00	.00	.00	.00	.00	.05	.00	.00	.00	.05	.22	.00	.30	.00	.04	.00	.18	.48	1.22	1.27

TABLE 34.—*Value of grades sawed from top logs of mature trees of different diameters breasthigh, expressed in dollars and cents.* (Values in this table obtained as indicated by $.032a_1'' + .030b_1'' +$ etc. Curves $Bval_1''$ and $Cval_1''$ shown in Figs. 191 and 192.)

Diameter breasthigh in inches	HIGH GRADES					INTERMEDIATE GRADES						LOW GRADES									Value per top log
	C. & Bet. 6/4	Mldg. Stock	No. 1 Shop 6/4	D. Sel. & Bet. 1″	Total	No. 1 Com. 1″	No. 2 Com. 1″	Shop 1″	No. 2 Shop 6/4	Shims	Total	Box 1″	Cull 2″	Box 6/4	No. 3 Shop 6/4	No. 3 Com. 1″	Plank 3″	4x4 & Lgr.	2x4 & wider No. 1 Dim.	Total	
	$.032a''_1+$	$.030b''_1+$	$.027c''_1+$	$.025d''_1=$	$Aval''_1$	$.022e''_1+$	$.018f''_1+$	$.018g''_1+$	$.018h''_1+$	$.007i''_1=$	$Bval''_1$	$.009j''_1+$	$.007k''_1+$	$.011l''_1+$	$.013m''_1+$	$.015n''_1+$	$.015o''_1+$	$.015p''_1+$	$.015q''_1=$	$Cval''_1$	B''_1
20	.00	.00	.00	.00	.00	.00	.07	.00	.00	.00	.07	.11	.00	.05	.03	.07	.00	.16	.48	.90	.97
21	.00	.00	.00	.00	.00	.00	.07	.00	.00	.00	.07	.11	.00	.07	.03	.07	.00	.16	.48	.92	.99
22	.00	.00	.00	.00	.00	.00	.07	.00	.00	.00	.07	.12	.00	.07	.03	.07	.00	.16	.50	.95	1.02
23	.00	.00	.00	.00	.00	.00	.07	.00	.00	.00	.07	.12	.00	.08	.04	.07	.00	.16	.50	.97	1.04
24	.00	.00	.00	.00	.00	.00	.07	.00	.00	.00	.07	.12	.00	.08	.04	.07	.00	.16	.50	.97	1.04
25	.00	.00	.00	.00	.00	.00	.07	.00	.00	.00	.07	.12	.00	.09	.04	.07	.00	.16	.51	.99	1.06
26	.00	.00	.00	.00	.00	.00	.07	.00	.00	.00	.07	.13	.00	.09	.04	.07	.00	.16	.51	1.00	1.07
27	.00	.00	.00	.00	.00	.00	.07	.00	.00	.00	.07	.13	.00	.10	.05	.07	.00	.16	.51	1.02	1.09
28	.00	.00	.00	.00	.00	.00	.07	.00	.00	.00	.07	.14	.00	.10	.05	.07	.00	.16	.52	1.04	1.11
29	.00	.00	.00	.00	.00	.00	.07	.00	.00	.00	.07	.15	.00	.11	.05	.07	.00	.16	.52	1.06	1.13
30	.00	.00	.00	.00	.00	.00	.07	.00	.04	.00	.11	.16	.00	.11	.06	.07	.00	.16	.52	1.08	1.19
31	.00	.00	.00	.00	.00	.00	.07	.00	.04	.00	.11	.16	.00	.12	.06	.07	.00	.16	.54	1.11	1.22
32	.00	.00	.00	.00	.00	.00	.07	.00	.04	.00	.11	.17	.00	.13	.06	.07	.00	.16	.54	1.13	1.24
33	.00	.00	.00	.00	.00	.00	.05	.00	.04	.00	.09	.18	.00	.14	.06	.07	.00	.16	.54	1.15	1.24
34	.00	.00	.00	.00	.00	.00	.05	.00	.05	.00	.10	.19	.00	.15	.08	.07	.00	.16	.54	1.19	1.29
35	.00	.00	.00	.00	.00	.00	.05	.00	.05	.00	.10	.20	.00	.16	.08	.07	.00	.18	.55	1.24	1.34
36	.00	.00	.00	.00	.00	.00	.05	.00	.05	.00	.10	.21	.00	.18	.08	.07	.00	.18	.55	1.27	1.37
37	.00	.00	.00	.00	.00	.00	.05	.00	.07	.00	.12	.23	.00	.20	.08	.07	.00	.18	.55	1.31	1.43
38	.00	.00	.00	.00	.00	.00	.05	.00	.09	.00	.14	.25	.00	.22	.09	.07	.00	.18	.55	1.36	1.50
39	.00	.00	.00	.00	.00	.00	.05	.00	.11	.00	.16	.27	.00	.25	.09	.07	.00	.18	.57	1.43	1.59
40	.00	.00	.00	.00	.00	.00	.05	.00	.13	.00	.18	.29	.00	.27	.09	.07	.00	.18	.57	1.47	1.65
41	.00	.00	.00	.00	.00	.00	.05	.00	.14	.00	.19	.31	.00	.31	.09	.07	.00	.18	.57	1.53	1.72
42	.00	.00	.00	.00	.00	.00	.05	.00	.16	.00	.21	.34	.00	.34	.10	.07	.00	.18	.57	1.60	1.81
43	.00	.00	.00	.00	.00	.00	.05	.00	.16	.00	.21	.37	.00	.39	.10	.07	.00	.18	.59	1.70	1.91
44	.00	.00	.00	.00	.00	.00	.05	.00	.18	.00	.23	.40	.00	.43	.10	.07	.00	.18	.59	1.77	2.00

AVERAGE VALUES FOR MILL OVER-RUN.

TABLE 35.—*Mill over-run for 16′ butt logs.*
(Values read from curves shown in Figs. 203, 204, 205 and 206.)

Diameter breasthigh in inches	IMMATURE Y. P. BUTT LOGS			MATURE Y. P. BUTT LOGS		
	Sawed out, bd. ft.	Log scale, bd. ft.	% over-run	Sawed out, bd. ft.	Log scale, bd. ft.	% over-run
20	207	153	35.4	212	159	33.3
21	226	169	33.6	236	179	31.9
22	247	186	32.3	261	199	31.0
23	269	205	30.9	287	221	29.9
24	293	226	29.6	315	244	29.0
25	317	246	28.7	344	269	28.0
26	342	267	28.0	374	294	27.3
27	371	290	27.4	405	320	26.5
28	399	315	26.6	437	347	26.0
29	430	340	26.1	470	375	25.3
30	462	368	25.7	505	403	25.2
31	497	395	25.4	542	434	25.1
32	531	424	25.2	580	466	24.5
33	570	455	25.0	620	498	24.4
34	608	487	24.8	661	532	24.3
35	650	519	24.7	706	569	24.2
36	691	554	24.7	752	606	24.0
37	736	589	24.6	798	643	24.0
38	781	627	24.6	845	683	23.8
39	829	664	24.5	896	723	23.8
40	876	703	24.5	948	766	23.7
41	926	745	24.4	1003	810	23.7
42	979	786	24.4	1058	856	23.6
43	--------------	--------------	--------------	1116	903	23.5
44	--------------	--------------	--------------	1175	952	23.5

TABLE 36.—*Mill over-run for top logs from immature trees.*

Diameter breasthigh in inches	Sawed out, board feet	Log scale, board feet	% over-run
20	46	26	77
21	46	26	77
22	48	26	84
23	49	27	81
24	50	27	85
25	53	27	96
26	54	28	93
27	55	28	96
28	57	29	96
29	59	30	96
30	60	32	88
31	62	33	88
32	63	34	85
33	65	35	86
34	67	37	81
35	69	39	77
36	73	41	78
37	76	43	77
38	79	45	76
39	83	47	77
40	87	50	74
41	94	53	77
42	101	56	80

GENERAL SUMMARIES

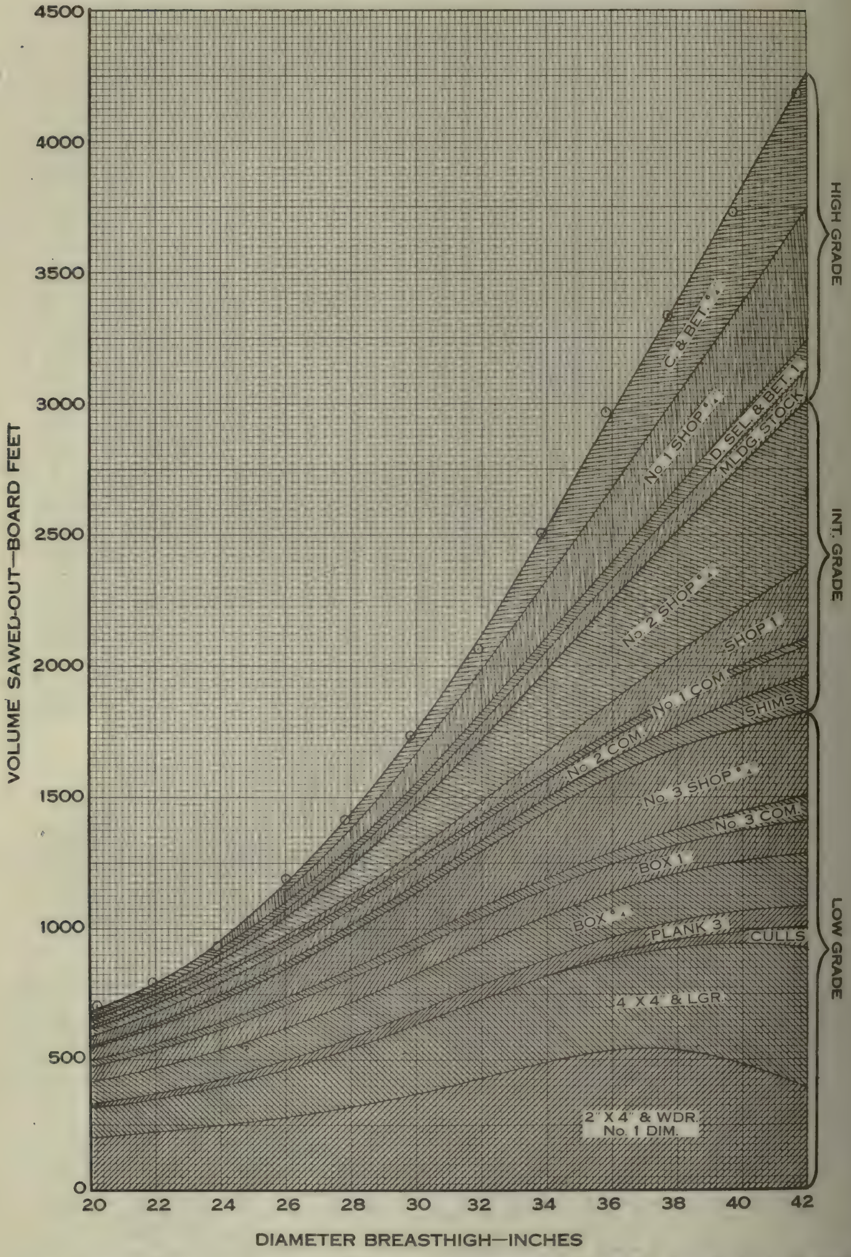


FIG. 209.—A graphic representation of the average volume in board feet of each grade sawed from immature trees of different diameters breasthigh. (Values given in Table 3.) This summary diagram shows at a glance the relative weights of the various grades, and is constructed by plotting the sum of the individual grades under the total sawed out curve. (The whole = the sum of all of its parts.)

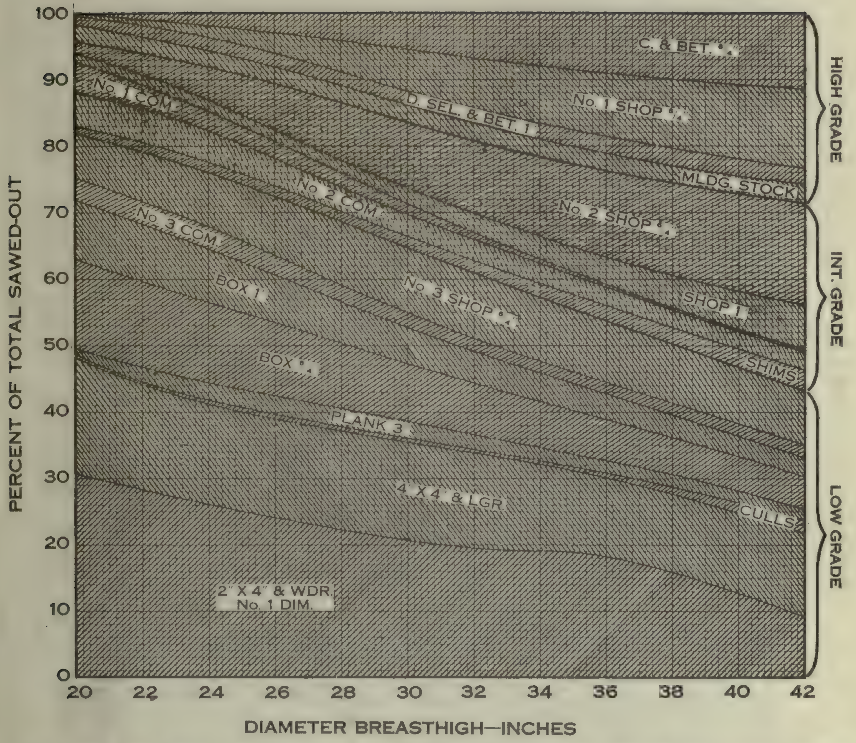


FIG. 210.—A graphic representation of the average per cent of each grade, based on total sawed out, from immature trees of different diameters breasthigh. (Values given in Table 5. This summary diagram shows at a glance the relative importance of the various grades, and is constructed by graphically adding the per cent of grades from trees of different diameters.

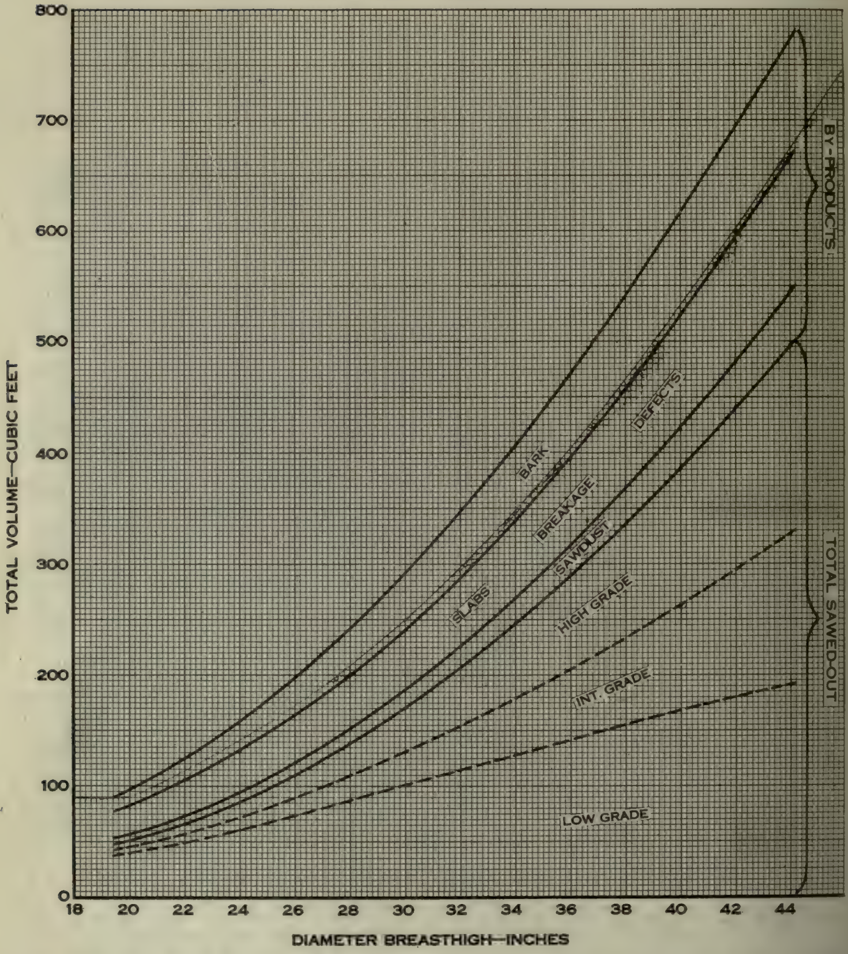


Fig. 211.—A diagram showing the average total yield in cubic feet of lumber and by-products from mature western yellow pine trees of different diameters breasthigh. (Values given in Table 37.)

- Average total volume in cubic feet of wood and bark between stump and height where the tree is 6" outside bark.
  - Total sawed out.
    - High grade lumber.
    - Intermediate grade.
    - Low grade.
  - By-products.
    - Bark.
    - Slabs, breakage and defects.
    - Sawdust.

TABLE 37.—*The average total yield in cubic feet of lumber and by-products from mature western yellow pine trees of different diameters breasthigh.* (A graphic representation of these values given in Fig. 211.)

Diameter breast-high in inches	VOLUME IN CU. FT. CONTAINED IN MERCH. LENGTH								Total sawed out + by-prods., cu. ft.
	Low grade +	Int. grade +	High grade =	Total sawed out	Sawdust from lumber sawed +	Slabs breakage and defects +	Bark =	By-products	
20	41	5	5	51	6	26	14	46	97
21	44	7	7	58	6	30	16	52	110
22	49	8	9	66	8	32	19	59	125
23	54	10	11	75	8	35	23	66	141
24	61	11	14	86	9	38	25	72	158
25	67	13	17	97	10	41	29	80	177
26	74	16	20	110	11	43	33	87	197
27	80	19	25	124	12	45	38	95	219
28	88	22	28	138	14	48	42	104	242
29	94	26	34	154	15	50	47	112	266
30	101	30	40	171	16	54	51	121	292
31	108	35	45	188	18	57	55	130	318
32	115	39	53	207	19	61	60	140	347
33	121	46	59	226	21	66	63	150	376
34	128	51	67	246	23	70	68	161	407
35	135	57	75	267	25	75	70	170	437
36	142	63	84	289	28	79	74	181	470
37	148	71	93	312	30	84	79	193	505
38	156	77	103	336	32	89	83	204	540
39	162	86	112	360	35	94	89	218	578
40	168	95	123	386	37	100	94	231	617
41	174	105	133	412	40	106	97	243	655
42	180	115	145	440	42	112	100	254	694
43	186	125	156	467	45	117	103	265	732
44	192	135	169	496	48	122	106	276	772

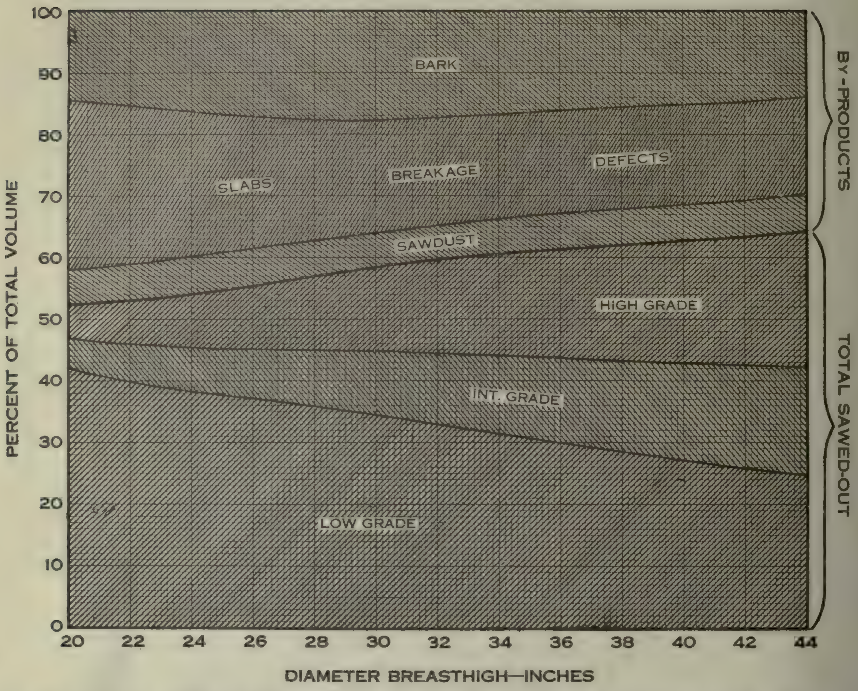


FIG. 212.—A diagram showing the yield of lumber and by-products, in per cent of average total yield, from mature western yellow pine trees of different diameters breasthigh. (Values given in Table 38.)

100 per cent.
- Per cent total sawed out.
  - Per cent high grade lumber.
  - Per cent intermediate grade.
  - Per cent low grade.
- Per cent by-products.
  - Per cent bark.
  - Per cent slabs, breakage and defects.
  - Per cent sawdust.

NOTE.—Average total yield = total volume of wood and bark between stump and a height where the tree is 6″ outside bark.

TABLE 38.—*The average yield of lumber and by-products, in per cent of average total yield, from mature western yellow pine trees of different diameters breasthigh.* (A graphic representation of these values given in Fig. 212.)

Diameter breast-high in inches	PER CENT OF TOTAL VOL. IN CU. FT. CONTAINED IN MERCH. LENGTH + BARK								Total sawed out + by-prods., cu. ft.
	Low + grade	Int. + grade	High = grade	Total sawed out	Sawdust + from lumber sawed	Slabs + breakage and defects	Bark =	By-products	
20	42.2	5.2	5.2	52.6	6.2	26.8	14.4	47.4	97
21	40.0	6.4	6.4	52.8	5.5	27.2	14.5	47.2	110
22	39.2	6.4	7.2	52.8	6.4	25.6	15.2	47.2	125
23	38.3	7.1	7.8	53.2	5.7	24.8	16.3	46.8	141
24	38.6	7.0	8.9	54.5	5.7	24.0	15.8	45.5	158
25	37.8	7.3	9.6	54.7	5.7	23.2	16.4	45.3	177
26	37.6	8.1	10.1	55.8	5.6	21.8	16.8	44.2	197
27	36.5	8.7	11.4	56.6	5.5	20.6	17.3	43.4	219
28	36.4	9.1	11.5	57.0	5.8	19.8	17.4	43.0	242
29	35.3	9.7	12.8	57.8	5.6	18.8	17.8	42.2	266
30	34.6	10.2	13.7	58.5	5.5	18.5	17.5	41.5	292
31	34.0	11.0	14.1	59.1	5.7	17.9	17.3	40.9	318
32	33.1	11.2	15.3	59.6	5.5	17.6	17.3	40.4	347
33	32.2	12.2	15.7	60.1	5.6	17.5	16.8	39.9	376
34	31.4	12.5	16.5	60.4	5.7	17.2	16.7	39.6	407
35	30.9	13.0	17.2	61.1	5.7	17.2	16.0	38.9	437
36	30.1	13.4	17.9	61.4	6.0	16.8	15.8	38.6	470
37	29.3	14.1	18.4	61.8	5.9	16.6	15.7	38.2	505
38	28.9	14.2	19.1	62.2	5.9	16.5	15.4	37.8	540
39	28.0	14.9	19.4	62.3	6.0	16.3	15.4	37.7	578
40	27.3	15.4	19.9	62.6	6.0	16.2	15.2	37.4	617
41	26.6	16.0	20.3	62.9	6.1	16.2	14.8	37.1	655
42	26.0	16.6	20.9	63.5	6.0	16.1	14.4	36.5	694
43	25.4	17.1	21.3	63.8	6.1	16.0	14.1	36.2	732
44	24.9	17.5	21.9	64.3	6.2	15.8	13.7	35.7	772

TABLE 39.—*Average determinations for immature western yellow pine.*

(Values read from curves shown in Figs. 4, 8, 22, etc., as indicated at bottom of table.)

DIMENSIONS			VOLUME IN BOARD FEET						VALUE				GROWTH IN			
													VOLUME		VALUE	
Diameter breasthigh in inches	Merch. length in feet	Vol. included in merch. length, cu. ft.	High grade +	Int. grade +	Low grade =	Total sawed out	As shown by Spaulding Log Scale	% over-run	Per tree	Per 1000 b. m. of merch. vol. of tree	Per 1000 b. m. of butt log	Per 1000 b. m. of top log	Board feet per dec.	% inc. per dec. based on total volume	Dollars and cents per dec.	% inc. per dec. based on total volume
20	84	80	29	95	561	685	430	59.0	$10.10	$14.75	$15.55	$13.25	50	7.4	$.80	7.4
21	87	89	39	105	590	735	470	55.5	10.90	14.85	15.95	13.25	55	7.5	.85	7.6
22	89	98	48	117	625	790	520	52.2	11.85	15.00	16.35	13.30	65	8.0	1.00	8.4
23	91	108	62	135	674	870	580	49.2	13.10	15.15	16.80	13.40	80	8.8	1.30	9.7
24	94	119	78	153	725	955	650	46.6	14.65	15.35	17.30	13.35	97	9.9	1.45	11.5
25	96	131	98	173	786	1060	735	44.1	16.30	15.55	17.90	13.35	116	10.8	2.15	12.9
26	99	143	125	196	854	1175	825	42.0	18.50	15.75	18.35	13.30	136	11.5	2.55	13.7
27	101	158	160	225	920	1300	930	40.1	20.90	16.05	18.95	13.40	155	12.0	2.95	14.0
28	104	173	202	255	988	1445	1040	38.5	23.60	16.35	19.50	13.60	174	12.3	3.35	14.0
29	106	189	243	292	1063	1585	1160	37.1	26.50	16.60	19.95	13.50	194	12.3	3.70	13.8
30	108	207	293	330	1133	1755	1300	35.9	29.55	16.85	20.45	13.45	210	12.0	4.00	13.5
31	110	225	348	371	1215	1925	1435	34.9	33.00	17.10	20.85	13.50	226	11.7	4.35	13.0
32	112	244	412	416	1291	2115	1580	34.0	36.65	17.30	21.15	13.45	238	11.2	4.60	12.4
33	115	265	474	471	1369	2315	1735	33.3	40.50	17.50	21.45	13.35	246	10.5	4.80	11.7
34	117	287	546	529	1451	2525	1900	32.7	44.75	17.70	21.80	13.30	250	9.8	4.95	11.0
35	119	309	620	594	1529	2735	2060	32.1	49.20	17.90	22.05	13.30	250	9.2	5.05	10.3
36	121	333	703	662	1595	2960	2230	31.8	53.50	18.05	22.45	13.15	249	8.4	5.10	9.5
37	123	357	782	738	1655	3160	2400	31.2	57.90	18.25	22.50	12.90	246	7.7	5.05	8.7
38	125	384	868	818	1701	3380	2580	30.8	62.30	18.40	22.65	12.90	240	7.0	5.00	8.0
39	127	410	951	904	1742	3600	2760	30.4	66.75	18.55	22.85	12.90	233	6.4	4.95	7.3
40	129	437	1043	995	1787	3825	2940	30.0	71.45	18.70	23.00	12.70	224	5.8	4.75	6.6
41	131	466	1132	1101	1808	4040	3120	29.8	76.00	18.85	23.05	12.70	214	5.2	4.55	5.9
42	133	497	1226	1198	1836	4260	3300	29.4	80.60	18.95	23.10	12.60	203	4.6	4.25	5.2
Figs.	4	8	22	34	52	11	10	200	68	70	70	70	87	88	91	92

TABLE 40.—*Average determinations for mature western yellow pine.*

(Values read from curves shown in Figs. 5, 9, 25, etc., as indicated at bottom of table.)

DIMENSIONS			VOLUME IN BOARD FEET						VALUE				GROWTH IN			
													VOLUME		VALUE	
Diameter breasthigh in inches	Merch. length in feet	Vol. included in merch. length, cu. ft.	High grade +	Int. grade +	Low grade =	Total sawed out	As shown by Spaulding Log Scale	% overrun	Per tree	Per 1000 bd. ft. of tree	Per 1000 bd. ft. of butt log	Per 1000 bd. ft. of top log	Board feet per dec.	% inc. per dec. based on total volume	Dollars and cents per dec.	% inc. per dec. based on total volume
20	83	83	58	69	500	625	410	52.0	$9.50	$15.10	$16.25	$13.60	31	5.0	$.60	6.0
21	87	94	67	78	558	715	480	48.5	11.00	15.50	17.25	13.70	34	5.1	.68	6.0
22	91	107	108	92	619	820	563	45.5	13.00	15.80	18.00	13.70	40	5.2	.72	6.2
23	94	118	130	110	692	930	655	43.0	15.00	16.05	18.75	13.70	50	5.4	.95	6.4
24	97	132	162	130	771	1060	755	41.0	17.30	16.30	19.35	13.60	60	5.7	1.15	6.6
25	100	148	194	156	856	1200	870	39.1	20.00	16.55	19.80	13.50	71	5.9	1.35	6.7
26	103	165	235	185	938	1360	990	37.5	22.75	16.80	20.25	13.40	82	6.0	1.60	6.8
27	105	182	285	220	1028	1525	1110	36.1	26.00	17.05	20.60	13.30	92	6.0	1.80	6.8
28	107	200	338	258	1109	1700	1255	35.0	29.40	17.25	20.90	13.25	101	6.0	2.00	6.7
29	110	220	396	301	1190	1880	1395	34.0	32.90	17.50	21.20	13.20	110	6.0	2.20	6.6
30	112	241	462	349	1276	2080	1555	33.1	36.80	17.70	21.45	13.20	120	5.9	2.38	6.5
31	114	264	537	401	1359	2290	1715	32.3	40.75	17.90	21.70	13.20	130	5.8	2.58	6.3
32	117	288	612	451	1442	2500	1895	31.7	45.10	18.10	21.90	13.20	139	5.6	2.75	6.1
33	119	812	695	516	1526	2735	2070	31.1	49.60	18.30	22.05	13.10	148	5.5	2.90	5.9
34	121	339	781	583	1609	2970	2265	30.5	54.60	18.50	22.25	13.05	155	5.3	3.08	5.7
35	123	366	872	661	1688	3220	2465	30.1	59.75	18.65	22.40	13.00	162	5.1	3.20	5.4
36	125	395	977	744	1764	3480	2680	29.6	65.40	18.75	22.50	12.95	169	4.9	3.35	5.2
37	127	425	1081	830	1846	3750	2890	29.2	71.00	18.90	22.60	12.90	175	4.7	3.50	5.0
38	129	457	1191	917	1924	4030	3130	28.8	76.85	19.00	22.75	12.85	180	4.5	3.65	4.7
39	131	488	1299	1012	2007	4320	3360	28.5	83.00	19.15	22.85	12.80	184	4.2	3.75	4.5
40	133	523	1425	1120	2085	4625	3620	28.1	89.25	19.25	23.00	12.70	188	4.0	3.85	4.3
41	135	558	1545	1226	2167	4940	3870	27.9	95.80	19.35	23.15	12.65	190	3.8	3.92	4.1
42	137	595	1679	1340	2256	5270	4140	27.6	102.50	19.45	23.30	12.55	190	3.6	4.00	3.8
43	138	630	1812	1462	2329	5590	4400	27.3	109.30	19.50	23.45	12.50	190	3.4	4.03	3.6
44	140	667	1948	1586	2401	5930	4670	27.0	116.25	19.55	23.50	12.45	191	3.2	4.05	3.4
Figs.	5	9	25	37	53	13	12	202	69	72	72	72	89	90	93	94

SECOND EDITION

Conservation of Natural Resources

A personal appeal is made to the California School Teacher, to take this little manual and use it to the future good of the State you serve. Read it. Surely something in its varied music will strike a responsive chord in you that will vibrate long enough to affect in turn some of the young people with whom you labor, the young people who will so soon be the old people, the young people who so soon will have the destiny of the Golden State in their hands to do with as they may.

Read it. Try to find at least one idea that is worth passing on. Then, pass it on.

And may the Future rise up and call you blessed. May it enshrine you in memory as One who would gladly learn and gladly teach.

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THE SUPERINTENDENT OF PUBLIC INSTRUCTION

CALIFORNIA STATE PRINTING OFFICE

SECOND EDITION.

CONSERVATION OF NATURAL RESOURCES.

INTRODUCTORY BY THE SUPERINTENDENT OF PUBLIC INSTRUCTION.

A Word to the People of California.

My friends, during the past year I have become possessed by the idea that the largest, the most truly patriotic, the most vitally important movement in this nation to-day is the one looking to the Conservation of our Natural Resources. This has been large enough to call together Conferences of Governors, to cause the appointment of National and State Commissions, and to engage the earnest attention, the gravest concern, of the greatest and most brilliant minds of our continent. It is patriotic, for it looks to the preservation of our fatherland into the future with its power and glory undimmed. It is vitally important, for without it our nation is doomed to go down to poverty and weakness. It is unselfish, for it looks forward to the welfare of those who come after us, rather than for our own little personal benefit now. It is a vital and a worthy thing, however we view it.

I have become possessed by the idea, too, that it is highly important for the *school people* of this State to join in this movement; for them to grasp its significance, appreciate its momentum, take hold of it strongly and intelligently. Such a movement as this must fail unless it can be projected into the future. It can only be projected into the future through the *children* of the nation. If it would really get permanently into the hearts of the People, it must filter through the Children.

I conceive it to be a patriotic duty resting upon every teacher, every superintendent, every school officer, to take his share of responsibility in this thing; to read, to talk, to think, to inform himself about this great movement for Conservation—and then to pass the spirit of it all along to the Children. In no other state or country is such variety and wealth of natural resources to be found as in California. Nowhere else is it being squandered with such careless hand, nor is there elsewhere such necessity for wise and thoughtful and far-seeing School People.

These reasons impel me to collect from letters, talks, newspapers, addresses, magazines, this little handbook of Conservation. It is meant to give a notion of what people are thinking and saying about the subject. I hope it can be accepted as a start in the right direction, and that it may lead toward good citizenship and the general weal.

Very truly yours,

EDWARD HYATT.

THE CASE OUTLINED.

What Does It Mean?

Just what does it mean—this Conservation of Natural Resources? Why, it means simply the wise care and use of our forests, our mines, our water, our soil. These are the fundamental sources of wealth that have been given to us by nature.

Why Are We Great?

Why is our nation one of the greatest in the world? Is it because we are stronger people, better people than the rest of the world? Not at all. It all rests upon the wonderful, the amazing, natural resources of North America. The great fortunes, the great cities, the great achievements of this nation, past and future, all depend upon our natural resources.

Where Does Our Money Come From?

Whence comes the money of the thousands of rich Americans who set all Europe agape? Whence come the funds to construct the great skyscrapers, to rebuild ruined cities, to make fleets of warships, transcontinental railroads, interoceanic canals and the other titanic undertakings that we are continually carrying out?

From Our Natural Storehouses.

It all comes from American copper, or wheat or lumber or coal or oil or gas or iron; or from the railroads or ships hauling these things; or from trading with the people who work in these things; or from the utilities of the cities that grow upon these things. Everything in all our power and civilization and luxury goes straight back to our natural storehouses of wealth. And we got them so easily that we do not even appreciate them as yet.

Suppose They Were Gone?

But suppose these storehouses were gone, or nearly empty? What would American enterprise amount to if it had nothing to exploit? What figure does a poverty-stricken nation cut in the world? What rich and populous nations in history have not gone down into groveling insignificance by squandering their natural resources?

Unthinking Babes.

Up to date we have been careless, heedless children with all our resources, giving them away, destroying them, wasting them with lavish hands, and with no thought of the morrow. He who can destroy most of our public property in the shortest time most excites our childish admiration. We have been busily playing our little games, paying no attention while some of the boys have set the house afire.

Something Is Doing.

But now an awakening seems to be coming. Its first tangible appearance was a Conference of Governors of the states and territories of the United States at the White House in Washington, presided over by President Roosevelt. Very many of the wisest and ablest men of the United States took part in this Conference—statesmen, philosophers, captains of industry. The Conference was followed by the formation of a National Conservation Commission, and later by the formation of a Conservation Commission in California.

The General Plan.

But any plan will fall down utterly, will come to naught, will turn to ashes in our grasp—*unless it can be backed up, supported, urged on by a strong, stern, unsleeping Public Opinion.*

Therefore It Is.

Therefore it is that the matter must be carried to the people, to the teachers, to the children. They must learn the facts and form their sentiments and see their duty. Commissions and legislatures will accomplish nothing unless we can wake the patriotic spirit of the people. The movement for Conservation can go no further than public opinion will carry it; but it will go fully as far as public opinion will go. [E. H.]

Aristotle says, "All who have meditated on the art of governing mankind have been convinced that the fate of empires depends on the education of youth."

WHAT PEOPLE ARE THINKING.

Written in 1908.

This movement is so new that many of us do not yet appreciate its momentum. Most of us never even heard of it until within the last few months. Nothing can give us a better idea of it, perhaps, and nothing can be more interesting than to see what other people are really thinking and saying about it; particularly so if the other people are ones we respect or ones who have had unusual opportunity to know what they are talking about. With this in view the following expressions of individual opinion have been collected.

These can be used by a clever teacher in many ways. For instance, in the morning exercises, one can be read aloud by a pupil, or explained by the teacher. Another may be given as a declamation or a reading at some entertainment or patriotic celebration. Still another, perhaps, will yield quotations and strong points for debates, essays and other similar school activities.

Of course, if the spirit does not move the teacher to *use* these things, they all fall flat. But California teachers never lack for spirit.

A bit of our forest.

CALIFORNIA CONSERVATION COMMISSION.

This fine article by the Chairman of the State Conservation Commission is written in response to a request for a brief statement of what every boy and girl in California ought to know about conservation.

What would be thought of the man who, owning a coal mine, and a forest, and an oil well, and a stream of water, gave them all away, leaving his sons and daughters to buy, at prices fixed by those to whom he gave his property, their coal, their lumber, their oil, and even their drinking water?

Coal, forests, oil, water, are merely examples of the thousand-and-one things Nature has given us as natural resources, which we have been giving away from the very beginning of this nation.

Everybody to whom we have given natural resources makes, of course, a profit on the sale of those natural resources to us; and as these natural resources come nearer to being exhausted, or as our needs for them become greater, the prices we pay for them grow ever higher, the profits on them always greater.

Unless we stop giving away our natural resources, the fathers of to-day will be like the father who foolishly gave away all his property; and the boys and girls of to-day will be like the sons and daughters of that foolish father, stripped of their enormously valuable patrimony and compelled to pay always increasing prices, always greater profits, for the privilege of using that which their fathers gave away.

Conservation means that none of our natural resources, those that we have given away as well as those that we still own, shall be unnecessarily wasted or destroyed. It means that all our natural resources shall be used, in such quantities and at such times as the needs of the people require. It means that no natural resource shall be hoarded unused by those to whom we gave it, so that, because it is kept unused, the price of that which is used may be kept up and the final price of that which is not being used shall be all the higher.

Most of our natural resources are limited in quantity; if we use them, we shall exhaust them. For that reason, if for no other, it is the more necessary that the coal, the iron, the oil, the copper, etc., shall not be, for any reason, unnecessarily wasted or destroyed.

One wasteable and destructible natural resource, the forests, is especially necessary to the people. It furnishes us lumber, timber, etc. It also protects the streams and springs, from which we get our water supplies for the innumerable uses to which we already put water. Land irrigation, electric-power generation, domestic purposes are some of the necessary uses to which we put water. With every year the necessity for water becomes greater.

We have given away the far greater portion of our forests. The far greater portion of the forests we have given away has already been destroyed; the remainder will have been destroyed within the next fifty years. The reason for this destruction is that more money can be made in a shorter time by destroying than by conserving the forests. More money can also be made in a shorter time by wasting and destroying much of other natural resources—oil, gas, coal, etc.

The greater portion of the forests that we have not given away are being conserved in National Forests. Conserved forests are used by cutting only the ripe trees and permitting new trees to grow in their places. The conserved National Forests will forever furnish lumber to their owners, the people; they will, also forever, perform the still more important service of protecting from flood and drought our streams and our springs.

For neither the always-continuing supply of lumber from these conserved forests, nor for their protection forever of our streams, will we be called upon to pay anybody any profits. All the benefits and all the profits will go to the owners of the conserved forests, the men and women of to-day and to-morrow, just as all the profits from the forests we have given away have gone and will go to those to whom we gave them, just as the profits from all property go to those who own it.

The streams of California will run forever. To take the place of every drop of water that runs away to the ocean the sun pumps another drop up into the mountains. Our streams, which will never run dry, and are necessary to the men and women of to-day, will be doubly necessary to the men and women of to-morrow, who are the boys and girls of to-day.

Which is the better policy for the men and women of to-day and to-morrow: to continue to give away the water in our streams, or to keep that which we still own?

For the privilege of using the water we have already given away or shall give away we shall have to pay always more money and greater profits to those to whom we have given it or shall give it. For the use of the water that we have not given away and do not give away we shall be compelled to pay nobody any profits—its price will be only what it costs us to put it to our uses. That cost, plus profits, we are compelled to pay to private owners of the water.

It is foolish, of course, for anybody to give anything away and then to pay always more money and greater profits for the privilege of using that which he has given away. It is more foolish to give away that for which we have an important use and then to pay always more money and greater profits for the privilege of using that which we have given away, and to see those things unnecessarily wasted and destroyed in order that the most money may be collected from us in the shortest time. It is the height of foolishness to give away something that is absolutely and perpetually necessary for our use, and which can not be destroyed, and for the privilege of using which we, because of our absolute and perpetual necessities, will be forever compelled to pay more money and constantly increasing profits.

There is, to be sure, sentiment to be invoked in the argument for the conservation of our natural resources. But the men and women of to-day have the right to demand, from the merely prosaic standpoint of their necessities, from the sordid standpoint of dollars and cents, to be saved to them, that the giving away of their natural resources, and the consequent wastage and destruction of such of them as can be wasted and destroyed, shall cease. And the boys and girls of to-day, who will be the men and women of to-morrow, have the right to demand that their fathers and mothers shall not continue to give away, or even to sell, those natural resources which now belong to the people. The men and women of to-morrow have the right to demand that that which ought to be theirs, as it is their fathers and mothers, by right of inheritance, shall not be taken from them, and their already heavy burdens be incalculably increased thereby.

Conservation means much to the men and women of to-day; it will mean much more to each future generation of men and women that comes upon the stage of life. The grown-ups of to-day ought not to strip their children of those things which will be of great, absolute, necessity to them when they shall have grown up. The unnecessary burdens borne by the men and women of to-day, because so much of our natural resource-wealth has been given away, ought to be sufficient warning to those men and women not to increase those burdens on themselves nor to pass still greater ones on to be carried by their children.

GEORGE C. PARDEE.

The Ex-President of the United States.

"The necessity for a comprehensive and systematic improvement of our waterways, the preservation of our soil and of our forests, the securing from private appropriation the power in navigable streams, the retention of the undisposed of coal lands of the Government from alienation, all will properly claim from the next administration earnest attention and appropriate legislation.

Without the resources which make labor productive, American enterprise, energy, and skill would not in the past have been able to make headway against hard conditions. Our children and their children will not be able to make headway if we leave to them an impoverished country. Our land, our waters, our forests, and our minerals are the sources from which come directly or indirectly the livelihood of all of us. The conservation of our natural resources is a question of fundamental importance to the United States now.

The truth is that the overwhelming necessity for our doing something to conserve our natural resources is going to put us to a new test of the practical character of our system of government. It is going to involve the question of whether, with the changing conditions, with the closer relations and the interdependence of the various parts of this country, our National Constitution will furnish the means of meeting that necessity. Now, I have no doubt that it will.''

Wm. H. Taft.

A Famous Churchman.

''No policy of our National Government is more in keeping with those democratic principles upon which our Republic is founded than the conservation of our natural resources, and none is to have a greater influence upon the future prosperity of our land. Our fertile soils, our inland waters, our mines, and our forests are God-given heritages which belong no more to the present generation than to generations that are to come. It is our duty as American citizens to regard these resources as sacred trusts, to preserve them, and to use them wisely and with moderation, that we may, as far as possible, provide against the days of want that are surely approaching; and that when these days are at hand they may not come as a crushing retribution, but as a wholesome discipline by which we shall be taught the great lessons of thrift and foresight.''

Cardinal Gibbons.

The Great Commoner.

''It should be our purpose, not only to preserve the nation's resources for future generations by reducing waste to a minimum; we should see to it that a few of the people do not monopolize that which in equity is the property of all the people. The earth belongs to each generation, and it is as criminal to fetter future generations with perpetual franchises, making the multitude servants to a favored faction of the population, as it would be to impair, unnecessarily, the common store.

Money spent in care for the life and health of the people, in protecting the soil from erosion and from exhaustion, in preventing waste in the use of minerals of limited supply, in the reclamation of deserts and swamps, and in the preservation of forests still remaining and the planting of denuded tracts—money invested in these and in the development of waterways and in the deepening of harbors is an investment yielding an annual return. If any of these expenditures fail to bring a return at once the money expended is like a bequest to those who come after us. And as the parent lives for his child as well as for himself, so the good citizen provides for the future as well as for the present.''

William Jennings Bryan.

The President of the University of California.

''This small revolving globe we dwell upon has been used as a home by us humans, by us and our ancestors, for a goodly row of centuries. But we were too few and weak to master it and put it clean beneath our feet. It mostly got the best of us. Of late we have come to get the best of it. It used to thwart us, and steer us, and tell us what we must do. Now we tell it what we want to do, and make it do it for us. We have fettered its strengths with steel and made them work for us. We force its down-hill waters to carry us up hill. We use its own treasures of fuel to belittle its size and dignity; to curb it and humble it, and even to reshape it.

This is all very well, but of late men have been finding this robbing and humiliating of the prostrate body of nature so easy and so interesting as to make it a form of sport. They rob and exploit without reference to any present need, just to show what they can do. It is like the killing of the buffaloes for the fun of shooting, until all at once it appeared they were practically exterminated.

This generation will have for one thing at least a great name in history. Men of the future centuries will surely call it the generation of the great destroyers, and historians and economists will write of the riotous days of nineteen hundred, when the people used up all the petroleum, all the natural gas, all the anthracite and most of the other coal, and most of the handy iron. It will be the period when the forests were cut down or burnt up, the lands stolen, and the waters given away. We are sure to be the subject of earnest remark.''

Benjamin Ide Wheeler.

The Secretary of the Interior.

''Why should a great resource, which is owned by the people at large, be used by private interests, by somebody that is looking only to his own benefit, and not to the benefit of the people of the country? The people as a whole own these natural resources. They are not divided. But the people as a whole, as I say, own them, and it is for them to determine whether those resources shall be used for the benefit of all, or shall be turned over to be used unregulated for the benefit of those who may perchance first get a foothold in any special locality. In any law that is passed, in any theory of disposition that is adopted, we must look not only to their conservation and use, but we must look to the prevention of their monopolization in the hands of a few favored interests.''

James R. Garfield.

A Great Labor Leader.

''In our mad rush for spoils and profits we not only waste and destroy those material resources with which God has so bountifully endowed us, but we press forward in the race, sacrificing, unnecessarily, the lives and the comfort of our fellow-beings. It seems to me that the time has come when we should stop for a moment and think—not alone of those inanimate things that make for comfort and prosperity, but also of the men, and the women, and the children, whose toil and deprivation have made and will continue to make our country and our people the most progressive and the most intelligent of all the nations and of all the peoples of the earth.''

John Mitchell.

A California College President.

''The greatest results of the administration of President Roosevelt have been twofold: the awakening of the civic conscience in our country, and the movement towards the conservation of our natural resources. These two results are closely connected, and each movement strengthens the other. There is now nothing in American politics of greater practical importance than the preservation of our national domain, with all that it contains, and all this developed to the highest point of efficiency.

Of these elements, that of forest preservation now stands first in pressing importance and deserves the constant support of all good men. Very important is also the preservation of the birds, to which the Audubon societies are dedicated. The saving of the fisheries is likewise a matter of large moment to the future, and in this I am giving personally all the help I can.

As for the waters, soils and all such matters, our many centers of investigation and instruction in agriculture are giving splendid pledges for the future.''

David Starr Jordan.

Another Ex-President of the United States.

"In utilizing and conserving the natural resources of the nation the one characteristic more essential than any other is foresight. Unfortunately, foresight is not usually characteristic of a young and vigorous people, and it is obviously not a marked characteristic of us in the United States. Yet assuredly it should be the growing nation with a future which takes the long look ahead; and no other nation is growing so rapidly as ours or has a future so full of promise. No other nation enjoys so wonderful a measure of present prosperity which can of right be treated as an earnest of future success, and in no other are the rewards of foresight so great, so certain, and so easily foretold. Yet hitherto as a nation we have tended to live with an eye single to the present, and have permitted the reckless waste and destruction of much of our natural wealth.

The conservation of our natural resources and their proper use constitute the fundamental problem which underlies almost every other problem of our national life. Unless we maintain an adequate material basis for our civilization, we can not maintain the institutions in which we take so great and just a pride; and to waste and destroy our natural resources means to undermine this material basis."

THEODORE ROOSEVELT.

Still Another Famous Ex-President.

"Those most proudly happy in their sanguine Americanism, and most confident of our ability to accomplish all things, must confess that our national life has been habitually beset with careless wastefulness, and that a palpable manifestation of this wastefulness is seen in the destruction of tree growth and the denudation of watersheds on our Western lands. Laws passed with the professed intent of protecting our forests have been so amiably construed as to admit of easy invasion; and their execution has too often been lax and perfunctory. In the mean time, public opinion on this subject, which might be as effective as legal enactment, has comfortably slumbered.

Even if we now abjectly repent of our sins of omission and commission in our treatment of the forests and streams which nature has given us, and reproach ourselves for the neglect of a trust imposed on us for the benefit of future generations, we must at the same time humbly confess that the punishment we have suffered by flood, by drought, by tornado, by fire, by barrenness of soil, and by loss of timber value, is well deserved.

In these circumstances it is exceedingly gratifying to have an appropriate opportunity to congratulate those who have constantly labored in the cause of forestry and forest preservation, as well as those interested in the cognate subject of irrigation, upon the prospect that these topics are to have more prominent places in governmental care.

Through the teachings of intelligent forestry it has been made plain that in our Western localities ruinous floods and exhausting droughts can be largely prevented, and productive moisture in useful degree and at needed periods secured, by reasonable and discriminating preservation of our forest areas; the advocates of irrigation have been led to realize that it is useless to provide for the storage of water unless the sources of its supply are protected; and all those who, in a disinterested way, have examined these questions concede that tree growth and natural soil on our watersheds are more valuable to the masses of our people than the footprints of sheep or cattle.

The opportune time has arrived when effective public interest in forestry and forest preservation should be persistently aroused and stimulated.''

GROVER CLEVELAND in 1904.

A Famous Mining Engineer.

''The ever-increasing rapidity of exploitation consequent upon the exigencies of modern engineering and economic practice inevitably leads to an alarming diminution of the lives—if I may use that term—of our mineral products. The culmination of our mining industry is to be reckoned by decades, and its declension (if not practically its economic exhaustion) in generations, not in centuries.''

JOHN HAYS HAMMOND.

An American Political Economist.

''If we want to prolong American prosperity and maintain the high level of American wages, our wage being double that of the other nations of the earth, we must protect our facilities and enlarge our ability to produce and manufacture the things that we manufacture at the lowest cost. * * * If we had no advantage in the marketing of our goods, either in excellence or quality or cheapness of production, it simply would mean that American labor would be reduced to the labor of all other nations of the world, and if we want to maintain its high level we must protect the facilities that will enable us to produce our goods at the very lowest possible cost.''

WILLIAM S. HARVEY.

The State Geologist of West Virginia.

"Just as sure as the sun shines, and the sum of two and two is four, unless this insane riot of destruction and waste of our fuel resources which has characterized the past century shall be speedily ended, our industrial power and supremacy will, after a meteor-like existence, revert, before the close of the present century, to those nations that conserve and prize at their proper value their priceless treasures of carbon."

I. C. White.

A Captain of the Steel Industry.

"We are nationally in the position of a large family receiving a rich patrimony from thrifty parents deceased intestate. * * * Now, the first duty of such a family is to take stock of its patrimony; the next to manage the assets in such manner that none shall be wasted, that all be put to the greatest good of the living and their descendants."

Andrew Carnegie.

An Ex-Governor of California.

"Certainly this great nation must conserve the foundations of its prosperity if it would continued great. And certainly no state is more interested in the matter than California. Resources of every kind have been richly given to us—great forests, splendid soils, plentiful waters, valuable mines. It is more than ordinary business prudence for us to take stock of our inheritances and find out the best way to handle them in future. Our children have a right to demand that we pass this great property on to them unimpaired, so that they and their children's children may continue to live and to prosper."

Gillett.

The Governor of Utah.

"The great, broad principle underlying the subject of conservation is whether or not each succeeding generation can be sustained on the land without impoverishing it in any respect. Stated as a question it is, 'Will each generation have the land as rich as the preceding one?' It seems a simple question, and yet the safety and the lives of our children and our children's children will depend upon the answer. The forests, the streams, the soils, the minerals, and all the other natural elements of wealth should remain as nearly as possible undiminished as the centuries pass. All of this is in the hands of the people, with the possible exception of the preservation of the mineral wealth."

Cutter.

The Governor of Oregon.

"The conservation of the water supply is absolutely dependent upon the preservation of the upland forests. Opposition to the policy comes not from those interested in the development of the country and the perpetuation of our institution, but from the predatory classes, who care for naught but temporary gain."

CHAMBERLAIN.

The Governor of Idaho.

"We have built here a great nation, without a thought of to-morrow. We will grow still greater, even if we follow the same old methods that we have followed in the past. But we can not reach our full share of greatness as a nation unless, before it is too late, we throw safeguards around those resources that have made us the mightiest nation on the earth, so that they can be preserved and protected, that they may be developed to the greatest extent for the benefit of this and future generations."

GOODING.

Wastful lumbering. Wreckage of a Western forest after logging. The fire has already begun on it. What a boon a few square feet of this ground would be even now to many a family. The time is coming when every splinter of it will be keenly needed; its waste bitterly regretted. Millions upon millions of acres like this go up in smoke.

SOME CURRENT LITERATURE.

The following longer selections from magazines, addresses, newspaper articles, will give more complete and well rounded views of the conservation idea as a whole. Why would not this collection be just the thing for a reading circle or an improvement club to use? It is up to date, interesting, and vital to our State, to our Nation. The material has not before been brought together. It has cost a good deal of labor.

Is it not strange that our schools, preparing for citizenship, do not take up in some way this Conservation of Resources, so vital to every one of us, so necessary to the very existence of the nation?

Our boys and girls spend hours and days and weeks in studying intently the virtues and the defects of the Articles of Confederation, dead a hundred years! But they can not discover in their school that men are throwing away and giving away the land and the water upon which the real life of the nation is builded.

They toil and moil at length over the animosities of the Civil War, which were better forgotten; but they do not learn that their birthrights of soil are being swept out to the sea and that their birthrights in water are being seized by those who will thereby become their masters and their rulers in all time to come.

Is there not something here for schools to learn and teach?

WE ARE ALL RESPONSIBLE.

When expressing our indignation at the wicked waste of the people's heritages it is well to remember that it is the people who are to blame for it. You and I and all of us are the criminals, not merely the men and the corporations who have so largely profited by the wasted resources. It is easy to work up wrath and blow off steam about them; but we must remember that they have played the game according to the rules, and that we, the people, make or consent to the rules of the game—the laws. The big boys often try to change the rules and use them unfairly, doubtless, as in smaller games; but if all the other children attend to it, take an interest in it, stick together, they can make the rules right and keep the big fellows within bounds.

It is well to remember this: most of us, if we could, would do just what the "predatory rich" have done.

One of the worst things that have been done, probably the very worst, has been the taking away of the timber lands from the people. But how has this been done? By buying out small owners for small prices. Our careless and reckless law gives to any one 160 acres of timber land if he or she will make oath that it is for his own use, not to be used for the benefit of some one else. In my travels I find many people, nice people, school teachers, ministers, ladies and gentlemen, locating timber claims—and selling them as soon as title is complete, for a few hundred dollars—three hundred, five hundred, perhaps; yet the timber itself is really *worth* many thousands of dollars, to say nothing of the land on which it stands.

Thus, for an insignificant sum for our own selfish immediate use do we nice people sell the birthrights of our children's children. Thus the great timber corporations acquire empires of land and princely fortunes in timber. Thus does our country lose its heritage for all time. Wherefore remember that we, the people, have our share of responsibility in this thing. We accept these laws and help make them. We take a small share of the swag ourselves when we can get it.

The reason for the wasting and plundering and going to smash of this vast and splendid estate of ours is not hard to find. It is from a simple and natural cause, a universal law—*because we, the owners, have neglected it.* Any property, any enterprise, goes to wreck and ruin if it is not attended to, guarded, watched over, by its owners. What would happen to a great store or a mill or a mine if it were abandoned to whomever happened along? How would a farm prosper if none of its owners took the trouble to look after it? Why, even a $500 house in a little village will soon be damaged beyond repair, broken, run down, carried away, when it is not cared for by its owners! And who gets the blame in such case? Not the boys who throw stones through the windows nor the petty thieves who carry off the fence for kindling wood—but the people who own it and are responsible for it. WE ARE ALL RESPONSIBLE.

[E. H.]

* * *

TEACHING CONSERVATION.

But how can a teacher teach Conservation? By exuding it through the pores! If it gets in it will come out!

A wise teacher will find a hundred ways to drop good ideas into the hearts of her children.

For instance, in the careful use of the school supplies. Economy and wise care are virtues greatly to be desired in all our citizenry. The teacher is not working for the sake of saving a few cents for the school fund; but for the *habits* of the children, their way of looking at things, during all their future lives. Carelessness, extravagance, recklessness, are dangerous to the nation. The difference between conservation and reckless waste may be taught in the use of such a common thing as *paper,* for example. Indeed, paper is really one of our national resources, as it is made of wood pulp, and wood pulp is made from trees. A big edition of a Sunday newspaper requires perhaps a dozen acres of woodland. Every sheet of paper, every desk, every box, every splinter of wood that we see or use, represents trees, trees that were chopped from our forests. Every one of our eighty million people use more than seven times as much wood per year as do the people all over Europe. Every big city fire destroys a great and splendid forest. Millions upon millions of acres of woodland continually go into the ties along our railroad lines. Countless other forests are rotting away deep under ground in the coal mines and gold mines.

The teacher who goes into the subject with interest himself will find no lack of striking and interesting and valuable things to pass along to his flock; things that point to civic patriotism; things more vital to their fatherland than the waving of battle flags and defiance of the foreign foe! [E. H.]

THE CONSERVATION OF OUR NATURAL RESOURCES.

A Story with a Moral.

The conservation of our natural resources is a subject which has received little attention in the past; but the facts in the case are so simple, the principles so elementary, and our duty so clear, that they might be fitly presented in a story like one of the old fairy tales that we all loved when we were boys and girls. Such a story would run like this:

Once upon a time there was a young man who had been given a great property in a distant region, and who left home to take possession of it. When he reached his property he first made himself acquainted with it. As he explored it and studied its value he began to think how he would make his living out of it. The problem was not a hard one. He found that his property was wonderfully rich, and supplied his needs at the cost of far less exertion than he would have had to make at home, for it was a fair land, well watered, well timbered, abounding in game and fruits, with broad meadows for cattle and horses and sheep, and with no small store of rare and curious minerals and an outcrop of excellent coal. Life was easy, and he lived lavishly and joyously, after the initial hard work of moving in and building his house and raising his first crops was over. He had far more land than he could use, far more game, and what he lacked he was able to buy from home with furs, with timber, with minerals, and with the surplus of his crops.

By and by he saw and liked a girl, and finally married her. Together they prospered on the property, which seemed too rich to make it necessary for them to trouble about the future. Game was still plenty, though less so than at first; the timber, though growing less, was still abundant enough to last longer than they could hope to live; by breaking new land they could always count on marvelous crops; the coal was a little harder to get at, but still close to the surface, and besides the man only dug out the easiest to reach, and when the earth began to cave in he merely started again at a new place. His stock, grazing on the meadows, had trampled out some of the grass, but there was still no lack. That some day strangers would possess their property when they had done with it, and would find it somewhat run down, did not trouble these two good people at all.

But children came to them with the years, and by and by these children began to grow up. Then the point of view of the man and his wife changed. They wanted to see their sons and daughters provided for and settled on this property of theirs, and they began to see that what was enough and to spare for them would not support all their children in the same comfort unless they themselves used it with better foresight. Through thinking of their children they were led to live more in the future.

They looked forward and said to themselves: "Not only must we meet our own needs from this property, but we must see to it that our children come in for their fair share of it; so that after a while the happiness we have had here may be carried on to them." So the family established itself. The man became respected, and his children grew up healthy and happy around him; and when in the fullness of time he passed away and his children took the place in which he had stood, because of his foresight and care they enjoyed the same kind of prosperity he had enjoyed.

It is a perfectly simple story; we all of us can name scores of men who have done this same thing. The men and the women who do it are not famous, are not regarded as remarkable in any way; they are simply good, everyday, average citizens, who are carrying out the duties of the average citizen.

What Have We Done with Our National Resources?

Once upon a time there was a young nation which left its home and moved on to a new continent. As soon as the people who formed the first settlements began to examine the value and condition of this new continent, they found it marvelously rich in every possible resource. The forests were so vast that, in the early days, they were not a blessing, but a hindrance. The soil was so rich and there was so much of it that they were able at first only to cultivate the edges of their great property. It was quite plain to these people in the early times that, however much land they might cover, however much they might waste, there was always going to be plenty left. As time went on they discovered greater and greater resources. They found wonderfully rich deposits of metallic ore; great oil and gas fields, and vast stretches of the richest bituminous and anthracite coal lands; noble rivers flowing through broad expanses of meadow; rich alluvial prairies; great plains covered with countless herds of buffalo and antelope; mountains filled with minerals; and everywhere opportunities richer than any nation had ever found elsewhere before.

They entered into this vast possession and began to use it. They did not need to think much about how they used their coal, or oil, or timber, or water—they would last—and they began to encroach on the supply with freedom and in confidence that there would always be plenty. The only word with which they described what they had, when they talked about it, was the word "inexhaustible."

Let us see for a moment what the course of development of this young nation was. First of all they needed men and women to settle on the land and bring up children and have a stake in the country. That was absolutely necessary before there could develop the great nation which some of them saw ahead. As the population spread there arose a need that great systems of transportation should be built to knit the country together and provide for the interchange of its products. These railroads called for iron, coal, and timber in great quantities. Then began an unprecedented demand upon the forests. They could not build those transcontinental railroad lines without millions upon millions of railroad ties cut from the forests of the country; and they could not mine the iron and coal except as the forests gave them the means of timbering their mines, transporting the ore, and disposing of the finished product. The whole civilization which they built up was conditioned on iron, coal, and timber. As they developed their continent, richer than any other, from the east coast to the west, new resources became revealed to them, new interests took possession of them, and they used the old resources in new ways. In the East, the rivers meant to them only means of transportation; in the West they began to see that the rivers meant first of all crops; that they must put the rivers on the land by irrigation before they could grow wheat, alfalfa, fruits, sugar beets, and other crops that make the West rich. They found that to feed the vast population which had grown up in the East they must have the vast ranges of the West to grow meat. They found that the resources of soil and water which produced the wheat, the cotton, and the meat—of iron and coal, and of timber, together made up the working capital of a great nation, and that the nation could not grow unless it had all of these things. In taking possession of them our nation used with greater effectiveness, greater energy and enterprise, than any other nation had ever shown before. Nothing like our growth, nothing like our wealth, nothing like the average happiness of our people can be found elsewhere; and the fundamental reason for this is, on the one side, the vast natural resources which we had at hand, and on the other side the character, ability, and power of our people.

Now what have we done with these resources which have made us great, and what is the present condition in which this marvelously vigorous nation of ours finds itself? The keynote of our times is "development." Every man from New York to San Francisco looks to the development of the natural resources to produce the advantages and the opportunities he wants for his neighbors and his friends. Any one who questions the wisdom of any of the methods we are using in bringing that development to pass, because he believes we are making mistakes that will be expensive later on, is in danger of being considered any enemy to prosperity. He is in danger of having it thought of him that he does not take pride in our great achievements, that he is not a very good American. But in reality it is no sign that a man lacks pride in the United States and the wonderful things our people have done in developing this great country because he wants to see that development go on indefinitely. On the contrary, real patriotism and pride in our country make it the first of all duties to see that our nation shall continue to prosper. In sober truth, we have brought ourselves into a condition in which the very serious diminution of some of our most necessary resources is upon us.

What We Face.

Forest Resources.—A third of the land surface of this country was originally covered with what were, all in all, the most magnificent forests of the globe—a million square miles of timberland. In the short time, as time counts in the life of nations, we have been here we have all but reached the end of these forests. We thought it unimportant until lately that we have been destroying by fire as much timber as we have used. But we have now reached the point where the growth of our forests is but one third of the annual cut, while we have in store timber enough for only twenty or thirty years at our present rate of use. This wonderful development, which would have been impossible without the cutting of the forests, has brought us where we really face their exhaustion within the present generation. And we use five or six times as much timber per capita as the European nations. A timber famine will touch every man, woman, and child in all the land; it will affect the daily life of every one of us; and yet without consideration, without forecast, and without foresight, we have placed ourselves, not deliberately, but thoughtlessly, in a position where a timber famine is one of the inevitable events of our near future.

Canada can not supply us, for she will need her timber herself. Siberia can not supply us, for the timber is too far from water transportation. South America can not supply us, because the timbers of that vast continent are of a different character from those we use and ill adapted to our need. We must suffer because we have carelessly wasted the forest, this great fundamental condition of success. It is impossible to repair the damage in time to escape much suffering, although not too late to work hard to reduce it as much as we can.

Minerals, Oil, and Natural Gas.—But forests only begin the story of our impaired capital. Our anthracite coals are said to be in danger of exhaustion in fifty years, and our bituminous coals in the beginning of the next century; some of our older oil fields are already exhausted; the natural gas has been wasted, burning night and day in many towns until the supply has failed. Our iron deposits grow less each year.

Our ranges in the West, from which we first drove the buffalo to cover them again with cattle and sheep, are capable of supporting but about one half what they could under intelligent management, and the price of beef is raised accordingly. Nearly every one of our wonderful resources we have used without reasonable foresight or reasonable care, and as each becomes exhausted a heavier burden of hardship will be laid upon us as a people.

Now what is our remedy? The remedy is the perfectly simple one of common sense applied to national affairs as common sense is applied to personal affairs. This is no abstruse or difficult question. We have hitherto as a nation taken the same course as did at first the young man who came into possession of his new property. It is time for a change.

It is true that some natural resources renew themselves while others do not. Our mineral resources once gone are gone forever. It may appear, therefore, at first thought that conservation does not apply to them, since they can be used only once. But this is far from being the fact. Methods of coal mining, for instance, have been permitted in this country which take out on the average but half of the coal. Then in a short time the roof sinks in on the other half, which thereafter can never be mined. Oil and natural gas also have been and are being exploited with great waste and as though there never could be an end to them. The forests we can replace at great cost and with an interval of suffering.

Soil Waste.—The soil which is washed from the surface of our farms every year to the amount of a billion tons, making, with the further loss of fertilizing elements carried away in solution, the heaviest tax the farmer has to pay, may in the course of centuries be replaced by the chemical disintegration of the rock; but it is decidedly wiser to keep what we have by careful methods of cultivation. We may very profitably stop putting our farms into our streams, to be dug out at great expense through river and harbor appropriations. Fertile soil is not wanted in the bed of a stream, and it is wanted on the surface of the farms and the forest-covered slopes of the mountains. Yet we spend millions upon millions of dollars every year removing from our rivers what ought never to have got into them.

Waste Through Piecemeal Planning.

Besides exhausting the unrenewable and impairing the renewable resources, we have left unused vast resources which are capable of adding enormously to the wealth of the country. Our streams have been used in the West mainly for irrigation and in the East mainly for navigation. It has not occurred to us that a stream is valuable, not merely for one, but for a considerable number of uses; that these uses are not mutually exclusive, and that to obtain the full benefit of what the stream can do for us we should plan to develop all its uses together. For example, when the National Government builds dams for navigation on streams, it has often disregarded the possible use, for power, of the water that flows over those dams. Engineers say that many hundred thousand horsepower are going to waste over Government dams in this way. Since a fair price for power, where it is in demand, is from $20 to $80 per horsepower annually, it will be seen that the Government has here, developed, yet lying idle, a resource capable, under the right conditions, of adding enormously to the national wealth. So also in developing the western streams for irrigation, in many places irrigation and power might be made to go hand in hand.

Danger of Monopoly.

If the public does not see to it that the control of water power is kept in the hands of the public, we are certain in the near future to find ourselves in the grip of those who will be able to control, with a monopoly absolutely without parallel in the past, the daily life of our people. Let us suppose a man in a western town, in a region without coal, rising on a cold morning, a few years hence, when invention and enterprise have brought to pass the things which we can already foresee as coming in the application of electricity. He turns on the electric light made from water power; his breakfast is cooked on an electric stove heated by the power of the streams; his morning newspaper is printed on a press moved by electricity from the streams; he goes to his office in a trolley car moved by electricity from the same source. The desk upon which he writes his letters, the merchandise which he sells, the crops which he raises, will have been brought to him or will be taken to market from him in a freight car moved by electricity. His wife will run her sewing machine or her churn, and factories will turn their shafts and wheels, by the same power. In every activity of his life that man and his family and his neighbors will have to pay toll to those who have been able to monopolize the great motive power of electricity made from water power, if that monopoly is allowed to become established. Never before in the history of this or any other free country has there existed the possibility of such intimate daily friction between a monopoly and the life of the average citizen.

It has not yet occurred to many of our people that this great power should be conserved for the use of the public. We have regarded it as a thing to be given away to any man who would take it. We have carried over our point of view derived from the early conditions when it was a godsend to have a man come into the country to develop power, and we were willing to give him anything to induce him to come.

We have carried over that point of view into a time when the dread of monopoly of this kind ought to be in the mind of the average man everywhere. That is an instance of a resource neglected from the point of view of the public.

A New Point of View.

But this is a time to consider not one resource, but all resources together. Already here and there small associations of citizens have become possessed of certain facts, and have begun to work at certain sides of what is fundamentally one great problem. We have a drainage association, whose object is to make habitable millions upon millions of acres now lying waste in swamps all over the country, but capable of supporting in comfort millions of people. We have forestry associations, waterway associations, irrigation associations, associations of many kinds touching this problem of conservation at different points, each endeavoring to benefit the common weal along its own line, but each interested only in its own particular piece of the work and unaware that it is attacking the outside, not the heart of the problem. Now a greater thing is opening out in the sight of the people. This problem of the conservation of natural resources in a single question. Each of these various bodies that have been working at different phases of it must come together on conservation as a common platform. By the joining of these units we shall have a mass of intelligent, interested, public-spirited citizens anxious to adopt a new point of view about this country of ours.

That is the crux of the whole matter—a new point of view about our country. We have been so busy getting rich, developing and growing, so proud of our growth, that we have let things go on until some intolerable abuse has driven us to immediate action. It is time that we put an end to this kind of opportunism, of mere drifting. We must take the point of view taken by the average prudent business man, or man in any walk of life who has property and is interested in it. What the average man does in his own affairs is to foresee trouble and avoid it if he can. What this nation of ours is doing in this fundamental matter of natural resources is to run right into trouble head down and eyes shut, and so make that trouble inevitable before taking any step to prevent it. But it should not take long to reach the stage of national thought where we shall deliberately plan to avoid the difficulties which can be foreseen, if only we can bring together all who have already begun to concern themselves with one or another aspect of the conservation problem.

The Problem Before Us.

This nation has, on the continent of North America, three and a half million square miles. What shall we do with it? How can we make ourselves and our children happiest, most vigorous and efficient, and our civilization the highest and most influential, as we use that splendid heritage? Ought not the nation to undertake to answer that question in the spirit of wisdom, prudence, and foresight? There is reason to think we are on the verge of doing this very thing. We are on the verge of saying to ourselves: "Let us do the best we can with our natural resources; let us find out what we have, how they can best be used, how they can best be conserved. Above all, let us have clearly in mind the great and fundamental fact that this nation will not end in the year 1950, or a hundred years after that, or five hundred years after that; that we are just beginning a national history the end of which we can not see, since we are still young." In truth we are at a critical point in that history. We may pass on along the line we have been following, exhaust our natural resources, continue to let the future take care of itself; or we may do the simple, obvious, common-sense thing in the interest of the nation, just as each of us does in his own personal affairs.

On the way in which we decide to handle this great possession which has been given us, on the turning which we take now, hangs the welfare of those who are to come after us. Whatever success we may have in any other line of national endeavor, whether we regulate trusts properly, whether we control our great public service corporations as we should, whether capital and labor adjust their relations in the best manner or not—whatever we may do with all these and other such questions, behind and below them all is this fundamental problem. Are we going to protect our springs of prosperity, our sources of well-being, our raw material of industry and commerce, and employer of capital and labor combined; or are we going to dissipate them? According as we accept or ignore our responsibility as trustees of the nation's welfare, our children and our children's children for uncounted generations will call us blessed, or will lay their suffering at our doors. We shall decide whether their lives, on the average, are to be lived in a flourishing country, full of all that helps to make men comfortable, happy, strong, and effective, or whether their lives are to be lived in a country like the miserable outworn regions of the earth which other nations before us have possessed without foresight and turned into hopeless deserts. We are no more exempt from the operation of natural laws than are the people of any other part of the world. When the facts are squarely before us, when the magnitude of the interests at stake is clearly before our people, it will surely be decided aright.

CULTIVATE THE FORESTS.

This is a clipping from a fine article upon the Statesmanship of Forestry by Arthur W. Page in the World's Work Magazine for January, 1908. A number of the pictures in this volume are from the same source.

Many people consider the approaching timber famine with the same feeling of regret and helplessness with which they listen to the story of the extinction of the buffalo. They feel that both are wild things which must inevitably perish before the advance of civilization. But the forests, unlike the buffalo, thrive in captivity. A large proportion of the trees in a wild forest are not best suited to our use. They are of the wrong species—like weeds in a garden—are too old or crooked and have a variety of other blemishes; and, while doing us little good themselves, they prevent the growth of better timber. To destroy all the original growth and then plant a new forest on the devastated area seems illogical, but it is neither impracticable nor unprofitable, as the experience of Germany and experiments in this country show. It is much easier, however, and more profitable, gradually to turn the wild forests into cultivated ones.

The French began to do this in the fourteenth century. * * * France, as thickly settled as it is, has maintained its cultivated timber for five hundred years, while the West with its scattered population is about to make an end of its wild forests in seventy-five years. In contrast to the forestry conditions of France are those of southern Tunis. It was once a very fertile country, but the Arab conquest destroyed all the trees and now the ruins of its old capital, Suffetula, stand in an uninhabitable desert. "Not long after the conquest," says M. Jusseraud, "an Arab chronicler recalled in his book the former times of prosperity and added: 'But in those days, one could walk from Tripoli to Tunis in the shade.'"

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CONFESSION TO NEXT GENERATION.

Caustic clipping from a graduating address to the Fresno High School by Dr. Frederic Burk.

"We dislike to go on with these embarrassing confessions, but you will learn the whole wretched story yourselves sometime, and we may as well tell you. As for the coal and iron, our fathers left us enough to last for two or three thousand years if it had been economically mined according to some system established by law. We regret to tell you, upon the authority of Andrew Carnegie and John Mitchell, that we've wasted in getting out what we could use what should have lasted eighteen hundred or two thousand years. The coal may hold out another two hundred years and the iron one hundred years, but both will come high in your time. We wish we did not have to mention the oil and the natural gas, but we may as well tell you that we've sucked them out of the earth almost completely and wasted them.

Dear next generation, such is part of the shameful explanation truth compels us to make to you concerning the waste and loss of your patrimony. We've skimmed the cream and have led jolly lives—we do sincerely hope you like skimmed milk, and little of it. When you are shivering with the cold in a coalless country, when you are nursing one blade of grass to grow for you where two grew for us, when you have ceased automobiling on account of the high price of oil, then you'll remember us in our riotous plenty. Don't be too angry with us. We robbed you. We took the bread out of your mouths, you our babes, and fed it to the vultures who were fattening upon our national dishonor. But our sins have been the sins of ignorance rather than of wilfulness. Your fathers were happy, devil-may-care fellows, whose courage, as war patriots, you must in justice honor, but who never had any comprehension of the meaning of a civil patriot nor the slightest realization that it required any of the qualities of courage, self-sacrifice for the common good, and intelligence which in war patriotism we have exemplified."

* * *

OUR WATER LAWS.

Pointed statement from a letter by President Allison Ware, of the Chico State Normal School.

"Worst of all, the water running in our streams has been so carelessly handled by our laws, (patterned as they are after the laws of England, where water is a pest and the only thought is to get it off the place as quickly as possible,) that most of it is now in private ownership, much of it many times over, with results that have produced widespread discomfort and that clearly throttle the growth of the State as a land of farming.

A few things, it seems to me, the people of California must speedily come to understand. First, the wonderful value of water; what it means to the farmer, to the manufacturer, to the main sources of wealth of all sorts. Second, the endless litigation, fearful waste of water wealth, harsh water-lordism, an uneconomic application of streams to production; all the results of our foolish laws. Third, that there is a remedy, partial because we have been slow to seek it, but still a remedy that will save to the future the possibility of sustaining an agricultural community of two million prosperous homes in California.

As to this great subject of water in relation to agriculture in California, Bulletin 100, Department of Agriculture, contains the whole story and shows us our tardy remedy."

LAST OF THE BIG TREES.

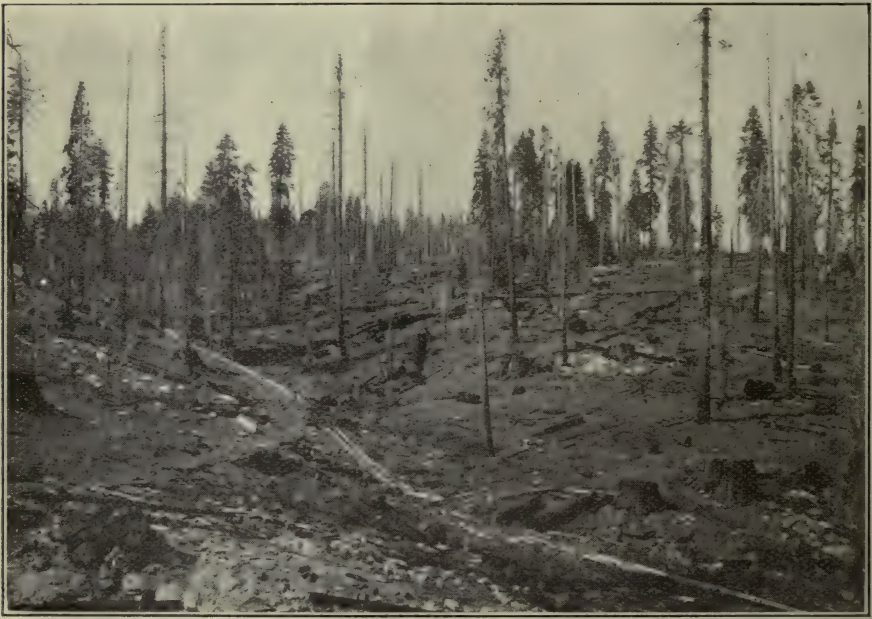
Extracts from a notable article in Collier's Weekly under the above title by Arthur Ruhl. Doubtless a good deal of this will seem merely sentimental to a hard-headed business man who deals in trees and lumber. Nevertheless, it is well to remember that the mightiest things are started by sentiments. Every great movement that has affected the destinies of mankind had its beginning in a mere sentiment that somehow found lodgment in some one's heart. The wise man harkens carefully to the drift of sentiment.

They rise up two hundred, two hundred and fifty, three hundred feet sometimes, the trunks bare of branches for seventy-five or a hundred feet, fluted, gray-brown columns like pillars of stone. Far overhead, the delicate tracery of their foliage weaves a roof which shuts out the direct sunlight and gives to everything below the soft twilight radiance of a cathedral. Like a Gothic cathedral, indeed, is the natural aisle with the fluted, columnar trunks rising side by side toward the mountain background, the mellowed light filtering through the arching roof far above.

Good-bye to the redwood monarch. It is on the way to the mill.

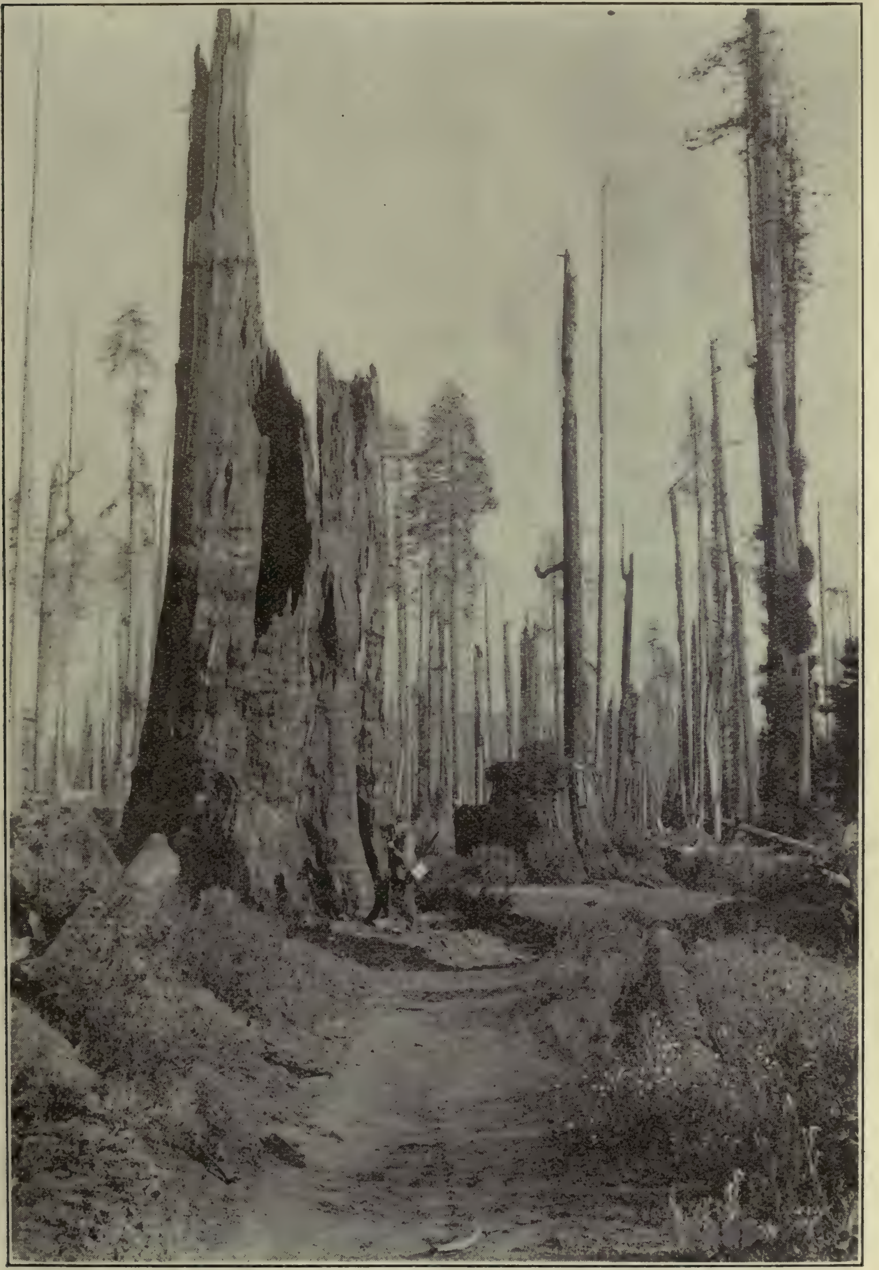
Even the curious fluted trunks and the color—a cinnamon turned stone-gray by age and weather—seems exotic and to belong to an older age, when strange and monstrous animals roamed the forests. And well they may look so, for they—and more especially their near relatives, the giant Sequoias of the Sierras—are the oldest living things in our world. The latter have conquered fire and snow and the other enemies that have attacked them through the centuries, and stood there, lofty and silent and serene, while wars have raged and been forgotten and religions grown up and fallen into decay. The redwoods proper, as these trees in the Bohemian grove are called, are not quite so ancient, but they were mighty trees, at any rate, before the Roman Empire fell, and they and their brothers may still be standing when the solitary New Zealander looks upon the ruins of St. Paul's—those at least which haven't been cut up into fenceposts and shingles.

To an outsider, the spell they cast necessarily overshadows the doings of the little humans playing at their feet. In the cool, fragrant interior of the grove, the hectic bustle of the ordinary world seems trifling and unimportant. Voices come pleasantly across the great spaces; even the humor of the street, provided it has a basis in reality, is mellowed and enriched and merged into the region of art. The grove becomes a world in itself—a more radiant world; you walk out into the open and are conscious of leaving some enchantment behind, of entering a more difficult, harsher, more material universe. Voices sound as from very far away through the trees, men lounging in groups here and there are listening and laughing carelessly—it is as though the blessings of humor and grace and happy insight belonged to all who breathed that air.



Big Tree land in Fresno County after lumbering and burning. No reproduction now, so farewell to the Big Trees.

An Easterner, a young poet and playwright, was a guest at the camp. He had never been West before, never seen the big trees. And it was into this pagan temple that he was led. The day before, he and some of his friends went to another forest nearby, the Armstrong grove. Here were the same trees, only a little wilder, with more of the natural undergrowth between. And that same day, in a newspaper, he read that the Armstrong grove had been sold to a lumber company. It was about midnight that night when I first caught sight of him on the



Chopped and burned redwood land in Del Norte County. Our descendants may enjoy skimmed milk.

opposite side of the circle that surrounded the huge club campfire. He came over to our side. He was like some one who had just seen innocent men condemned to death and knew that if he could not get help they would be executed the next morning. His voice shook as he spoke.

"Why, I've *seen* them," he said. "They are all numbered—61-73-87, ready to cut. They are just like these"—he motioned upward where the dark roof of the forest closed in far above the light of the fire. "And they're going to cut them down. Why, it seemed to me when I saw those numbers—you go over to-morrow morning and you'll understand—if a man could only prevent that destruction, could only save those trees! * * *"

The Giant Tree proper lives only in the thin, dry air of the Sierras, rarely below 5,000 feet altitude, climbing thence up to the 8,000-foot level and even higher, so that it may look, with little hindrance, to the bare peaks and the glaciers above. It is found in much less homogeneous forests than the redwood, sharing the dominion of these sunny plateaus with mighty sugar and yellow pines and spruces and firs. In the southern portions of the belt, along the Kaweah and Tule rivers, there are Giant-Tree groves that deserve to be called forests—vigorous young trees and saplings, growing beside their ancient, storm-stricken sires, but more often the Giant Trees bear much the same relation to the forest as a whole as is borne by the occasional primeval oaks found among the common second-growth timber in the "woods" of the East and Middle West.

A redwood forest in California in its natural state. Observe the shrubs and ferns that flourish in the cool aisles of the woodland.

The largest tree known is probably the "General Sherman," in the Giant Forest Grove in the Sequoia National Park, about forty miles east of the town of Visalia, in the central southern part of the State.

It has a circumference of 103 feet; 200 feet from the ground it is not less than 70 feet around, and even with its crown broken off it is 280 feet high.

It was of such trees as this, which, scarred by fire, broken off by storms or lightning, yet tower aloft in a majesty and beauty almost undimmed, as if gifted with eternal life, that John Muir wrote:

> "So exquisitely harmonious and finely balanced are even the very mightiest of these monarchs of the woods, in all their proportions and circumstances, that never is anything overgrown or monstrous looking about them. * * * No other tree in the Sierra forest has foliage so densely massed, nor presents outlines so firmly drawn and so steadily subordinate to a special type. A knotty, ungovernable-looking branch, five to eight feet thick, may be seen pushing out abruptly from the smooth trunk, as if sure to throw the regular curve into confusion, but as soon as the general outline is reached, it stops short and dissolves in spreading bosses of law-abiding sprays, just as if every tree were growing beneath some huge, invisible bell glass, against whose sides every branch was being pressed and molded, yet somehow indulging in so many small departures from the regular form that there is still an appearance of freedom. * * *

Here is the redwood forest after it has been "developed" by our wasteful methods.

> "As soon as any accident happens to the crown of these Sequoias, such as being stricken off by lightning or broken by storms, then the branches beneath the wound, no matter how situated, seem to be excited, like a colony of bees that have lost their queen, and become anxious to repair the damage. Limbs that have grown outward for centuries at right angles to the trunk begin to turn

> upward to assist in making a new crown, each speedily assuming the special form of true summits. Even in the case of mere stumps, burned half through, some mere ornamental tuft will try to go aloft and do its best as a leader in forming a new head. * * *
>
> "I never saw a big tree that had died a natural death; barring accidents, they seem to be immortal, being exempt from all the diseases that afflict and kill other trees. Unless destroyed by man, they live on indefinitely, until burned, smashed by lightning, or cast down by storms or by the giving way of the ground on which they stand. * * * The colossal scarred monument in the Kings River forest is burned half way through, and I spent a day in making an estimate of its age, clearing away the charred surface with an axe, and carefully counting the annual rings by the aid of a pocket lens. The wood rings in the section I laid bare were so involved and contorted in some places that I was not able to determine its age exactly, but I counted over four thousand rings, which showed that this tree was in its prime, swaying in the Sierra winds when Christ walked the earth. No other tree in the world, as far as I know, has looked down on so many centuries as the Sequoia, or open such impressive and suggestive views into history."

And it is monarchs like these, who have seen the sun rise on a million crystalline Sierra mornings, who have fought their centuries of battle against fire and winter snows and thunderbolts and winds, who must now fall before tiny scrambling humans with ravenous axes and be turned into posts and grapevine stakes. At the close of the same chapter quoted above is Muir's prophecy that *"unless protective measures be speedily invented and applied, in a few decades, at the farthest, all that will be left of the Sequoia gigantea will be a few hacked and scarred monuments."*

Yet all through the belt these wonderful monuments are being destroyed. They are not felled to make pillars for temples. No unusual or beautiful service is performed through their destruction. They are first chopped down, then, with enormous waste, blown to pieces with gunpowder, and then ironically split up into fence posts and grapevine stakes. That is about as low a task a good wood could be put to—only a step higher than the splinters from old boxes which elderly ladies stick into flowerpots to hold up geraniums.

The only grove thoroughly safe from destruction is the Mariposa, which is owned by the State of California. In the Sequoia and General Grant National Parks, which, theoretically, are owned by the nation, there are about 1,200 acres in private ownership. Captain Young secured options on the Sequoia National Park holdings a few years ago, and the Government could have bought them then, it is said, for the very reasonable sum of $86,000. However the owners may have acquired title, it is only fair to say that they have made no attempt to hold up the Government for an unreasonable price. As usual, however, Congress did not see fit to act. There is nothing to prevent the destruction of these trees, should the owners choose to cut them down, except the fact that there is no lumber road out of the park, and the Government has thus far declined to grant a right of way. If the owners chose to force their claim, however, it is extremely doubtful if the Government's position could be legally upheld.

The preservation of giant trees is a question for the people themselves. How much are these trees worth to them, not as lumber, but as monuments, as wonderful and beautiful relics of a vanished age? For they are relics and monuments—the world has no other Sequoias. They are either to be preserved or destroyed forever—like the Pyramids or the Parthenon. And although there are several groves, the number of trees which, in comparison with the majestic pines and firs and spruces round them, can properly be called ''giant'' trees is probably not more than five hundred.

Just what methods Government, State, and individuals should adopt is rather beyond the purpose of this article, which merely undertakes to explain what and where the giant trees are. To be sure, one can't help thinking of California millionaires. Some of them have public spirit and wish to do something for their country. Any man who saves one of these groves, or even one giant tree for the people bestows a gift which not only will do him honor during his lifetime, but will still be standing, as it is to-day, hundreds, possibly thousands, of years after all the vain little human structures of our day have crumbled to pieces or been pounded up into macadam streets.

* * *

DREDGER MINING.

Our laws are stupid, too, in regard to the dredger industry. They allow capitalists to come into our fertile valleys, pay big prices for fields, orchards, vineyards, and convert them into barren piles of rocks. This makes a temporary prosperity. The owners of the soil get a lot of money, work is plentiful, prices are good—and the capitalist carries away large profits, perhaps. But the brief prosperity passes away in a few years—and what of the land? It is no more! It would have otherwise been producing food, supporting people and paying taxes for four or five hundred years or four or five thousand—but now it is gone. It is a hideous desolation for all time to come.

There is something wrong in this. It is legal at present, but it is not moral. No one should have a right to destroy the Homes of the future. It is against the general good. We have a right to *use* the land—but not to *destroy* it. It is easily possible to dredge the land in such way that the good soil will remain on top, the cobblestones below—but that costs more money and the profits are cut down. It is also possible that a share of these ill-gotten profits might induce unpatriotic lawyers to hinder and delay the passage of restrictive laws on this matter for many years, while many future homes pass out of the world forever.

[E. H.]

* * *

THE LOSS OF OUR SOIL.

This striking statement is from The Outlook, edited by Lyman Abbott.

We are in the habit of speaking of the solid earth and the eternal hills as though they, at least, were free from the vicissitudes of time, and certain to furnish perpetual support for prosperous human life. This conclusion is as false as the term ''inexhaustible'' applied to other natural resources. The waste of soil is among the most dangerous of all wastes now in progress in the United States. In 1896 Professor Shaler, than whom no one has spoken with greater authority on this subject, estimated that in the upland regions of the states south of Pennsylvania three thousand square miles of soil had been destroyed as the result of forest denudation, and that the destruction was then proceeding at the rate of one hundred square miles of fertile soil per year. No seeing man can travel through the United States without being struck with the enormous and unnecessary loss of fertility by easily preventable soil wash. The soil so lost, as in the case of many other wastes, becomes itself a source of damage and expense, and must be removed from the channels of our navigable streams at an enormous annual cost. The Mississippi River alone is estimated to transport yearly four hundred million tons of sediment, or about twice the amount of material to be excavated from the Panama Canal. This material is the most fertile portion of our richest fields, transformed from a blessing to a curse by unrestricted erosion.

THE LARGEST NATIONAL TASK.

From the address of President Roosevelt at the meeting of the Conservation Conference held in Washington, D. C., December 8, 1908.

I welcome you to Washington and to the work you have gathered to do. No service to the nation in time of peace could be of greater worth than the work which has brought you together. In its essence your task is to make the nation's future as great as its present. That is what the conservation of our resources means. This movement means that we shall not become great in the present at the expense of the future, but that we shall show ourselves truly great in the present by providing for the greatness of our children's children who are to inherit the land after us. It is the largest national task of to-day, and I thank you for making ready to undertake it.

I am especially glad to welcome the co-operation of the states, through their Conservation Commissions and otherwise. Such co-operation gives earnest of mutual assistance between states and nation, and mutual benefits to follow. Without it the great task of perpetuating the national welfare would succeed, if at all, with difficulty. If states and nation work for it together, all in their several fields, and all joining heartily where the field is common, we are certain of success in advance. We are concerned with the people's rights; if this means national rights, well and good; if it means states' rights, well and good; we are for whatever serves the cause of the people's rights.

The results of the inventory of resources will be laid before the present conference by the National Conservation Commission. I shall not attempt to review these results further than to say that the more striking facts brought out at the conference last May are amply confirmed. These facts are sobering. No right-minded citizen would stop the proper use of our resources, but every good American must realize that national improvidence follows the same course and leads to the same end as personal improvidence—and no man is a good American if he does not think of future Americans, any more than a man is a good citizen if he does not think of his children's welfare; for there isn't any man whom we despise more than the man who has a good time himself and whose children pay for it. So with the nation; that nation is contemptible that riots in abundance by wasting the heritage it should leave to the citizens that are to come afterwards. Needless waste must stop. The time to deride or neglect the statements of experts and the teaching of the facts has gone by. The time to act on what we already know has arrived. Common prudence, common sense, and common business principles are applicable to national affairs just as they are to private affairs, and the time has come to apply them in dealing with the foundations of our prosperity.

THE WASTE IN MUD.

This article is from The Saturday Evening Post of March 27th. It is a fine example of modern American newspaper English. It tells the story in a deliciously whimsical, humorous way. Yet the grim facts stick out boldly all through it, in spite of its quips and jests. It is by Emerson Hough.

With the exception of that certain wicked uncle, of whom nothing ever was expected and of whom no good could be predicted, all your family, like the average American family, no doubt regularly went to church. Probably the majority stayed over for Sabbath-school in the little church with white walls and black walnut pews. You could not have been in a better place. At church or Sabbath-school you all stood in a row and sang that easy, lilting old hymn which says:

Little drops of water, little grains of sand,
Make the mighty ocean and the pleasant land.

You could not have sung a better song. We all used to sing that song with cheerfulness, indeed with enthusiasm—*Lit*-tle drops of wa-a-a-ter, *lit*-tle gra-ay-ins of sand, make the mighty *o-o*-shun, *an'* the pleh-heh-sent la-a-a-nd! That was the way it ran. After we had sung it we all went home and forgot all about it. The next Monday morning Dad went back to farming, just the way his Dad had, and the Dad who antedated that one, world without end; and not one of those Dads was ever wise enough to know the hymn was right, or to figure out what the hymn meant or ought to mean. It is a splendid hymn, full of vast elemental truth, and it has a lot to do with farming.

Heretofore, your folks and mine hadn't thought that geology had much to do with farming, any more than religion had. As a matter of fact, they both do. The only trouble is, the average American, like you and me, does very little thinking in religion, politics or business. The farmer knows the country immediately around him. The city man does not even know all of the city where he lives, only a little corner of it. It is this carelessness in religion, politics, business and geology which gives the sad-eyed Mr. James J. Hill still further opportunity to grieve over the future of this country.

What Mr. Hill sees in the time when five hundred millions of Japanese and Chinamen will be making all our manufactured goods under a scale of living so much cheaper than the American standard as to crush out all American competition. This means not only the fiercest struggle ever known for trade, but the fiercest struggle ever known for a mere living. It is the war between the Oriental standard of living and the American standard as we now know it. The decisive battle of that war must be fought on the American farm, not in the California legislature. The American standard of living is based on the theory of an exhaustless bank account. Our account has never been overdrawn, and we have never had our bankbook balanced. It is only now that a few of our wiser men begin to see that it is time for us to get a balance from the clerk at the desk. We have been checking out, like inebriated mariners, what we had or thought we had in this rich bank of America, land of the free, country of endless opportunity. Now we have used up our forests, are exhausting our mines at fearsome speed, have exterminated most of our wild game, endangered the food supply which comes from the waters, and, in general, done all we could to put an end to our great resources, recklessly spending not only our interest but also our principal. We have not even left unscathed the pleasant land. Not only are we using up at mad speed the natural products of the soil, but also are using up *the soil itself*.

A hundred acres of good land made worthless by flood. Orchards smothered and fence posts covered by sand.

If you think that the soil is exhaustless, or that it can be replaced, it might behoove you to take a homœopathic dose of geology and also take another guess. Mr. Roosevelt and most of the Congress of the United States would like to have us all take the trouble of studying the ground we stand on. Mr. Roosevelt's recent message asked us to pass our bankbooks in at the window for a balance. It is an unpleasant thing to do. There are always so many more vouchers out than we thought. The balance is always so much smaller than we thought, and the bank has such an unpleasant way of being right in its figures. Yet the time has come for a show-down between the American people and America itself.

Out on the Blackfoot Reservation there stands a tall, lone mountain, rising like a monument above the surrounding plain, and nearly detached from the Rockies, which lie behind it. This peak the Indians call Chief Mountain. Here the Blackfoot sometimes comes to pray. In his mysticism his prayer runs: "O Thou, at whose feet the buried years lie fallen!" That is to say, there is in his mind the thought of the slow forces of Nature. He reverences the idea of erosion. He would understand and not forget that hymn if he sung it, which in effect tells us that all we have in this world comes of the relations of soil and water. There will be a few million American farmers who will learn that same truth some time. The somewhat mad and drunken American people have ignored and inverted that truth heretofore. They have done all they could to go bankrupt, to ruin one of the richest portions of the earth's surface, one of the pleasantest lands ever taken over for human habitation, one obviously intended by the Great Forces as the place for the development of the highest form of civilization and the most splendid flowering of human endeavor.

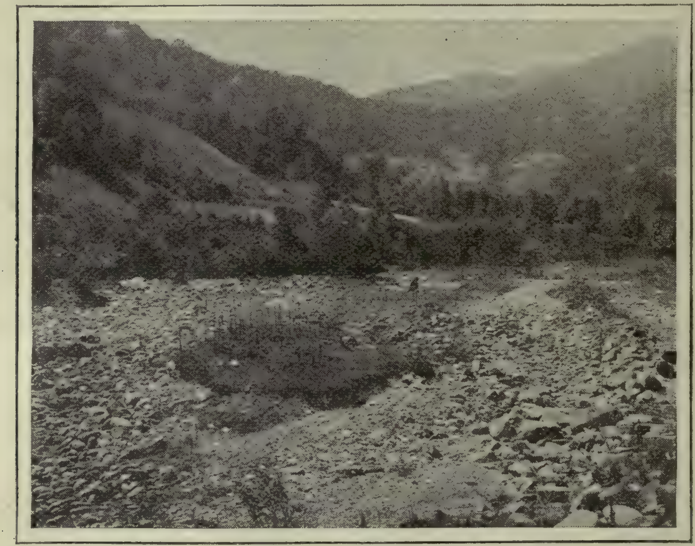
Wasted country, caused by removal of forest cover. Heavy rains wash the soil away, down to naked rock. The river channels are clogged and this region is useless, lost to the world.

What is the pleasant land, and where does it come from? Of course, the average man supposes that the soil was always there, like Uncle Joe Cannon, Niagara Falls and the tax deficit; but, as a matter of fact, the soil grew. In that vast story the action was rather more deliberate than that of a vaudeville sketch. Geology is not dramatic in that neurotic sense of the word which customarily we employ to-day. Yet you and I, and this country and other countries, are figures in the great drama. It might not harm us to note what a leading scientist says as to the time of the action of the play:

"For average rock under ordinarily favorable conditions in our range of climate, the usual estimate has been a foot of waste in four thousand to six thousand years, which includes the channel cutting and bank undermining. These are too rapid for ordinary soil-waste under our normal natural conditions. Without any pretensions to a close estimate, I should be unwilling to name a mean rate of soil formation greater than one foot in ten thousand years on the basis of observation since the glacial period. I suspect that, if we could positively determine the time taken in the formation of the four feet of soil next to the rock over the average domain where such depth obtains, it would be found above rather than below forty thousand years. Under such an estimate, to preserve good working depth, surface wastage should not exceed some such rate as one inch in one thousand years. When our soils are gone we too must go, unless we shall find some way to feed on raw rock or its equivalent."

As a result of deforestation of the hills above, a little stream swells to a torrent like this. The rich bottom land is carried away, leaving only rocks and gravel behind.

So there is something in the story of the pleasant land. Search all the dictionaries through, comb out all the rhetoric books, and you couldn't get a happier phrase than that: "The pleasant land." It is excellent. It is perfect. Like any other savage, you feel a deep thrill of delight when you see the vast pictures of the unhurt out-of-doors. You have delight in the sight of green trees, of growing grasses and nodding flowers. This panorama of hill and dale, of rolling lands and forest-covered valleys and lofty mountains pleases you. Why? It is because all this was laid out in the intent of Nature to *produce* you and me and *support* us. It is beautiful in the beauty of utility. It is laid out on precisely the right lines to keep up the balance of the aforesaid little drops of water and little grains of sand, of which the one supports the other in the making of this pleasant land. It got its contours out of that balance. We grew out of the contours. This vast and splendid landscape is the portrait of our mother. We forget the hymn about it. Like a weak, irritable, nasty-tempered child, we strike the great Mother in the face, presuming on her vast indifference or her vast pity. And all the while Man is only the last animal that has been invented, and some time there will be a successor for him. If we destroy the soil we hasten that day when the successor shall come. Now the undeniable truth is that we are spending more than our inch of soil per thousand years.



The soil of a whole valley washed away by a freshet. Observe the little island of good land left in the midst of a hopeless waste of cobblestones.

Civilized man, money-mad business man, crazed man, average man, is doing all he can to destroy the balance between the little drops and the little grains. Not only is he doing all he can to invite the successor of man in the scheme of life, but he is hastening all he can that incidental intermediate thing—to give it, perhaps, the only interesting form into which the statement can be put in the terms of commercial To-day—the show-down between the American standard of living and that of other peoples who never had so big a bank account as ours, and who, therefore, learn to save.

This hymn of the soil is the one great hymn. It sings of the one great heritage of life. We speak of this or that man "owning" thus or so much of the earth's surface. That, of course, is impossible. He takes it or borrows it, perhaps, but he can own no more than six feet of it, and that only for a short time. The soil belongs to Life. The "buried years" resent any embezzlement of our great heritage. The soil is owned by plants, by animals, by men of this or that nation, this or that age, that past, yonder future. If we sin against the soil, ours will be the Great Punishment—which is to say, extinction, oblivion. If you plow badly, it is you for the star-dust!

Even before Wall Street was invented there was more water than anything else in the world. Finally, on the little crust of land some tiny plant began to grow, no one knows just when. Perhaps at one time the plant could not have told whether it was a plant or an animal, but, anyhow, in time it turned into some green thing which looked tempting to some old Ichthyosaurus, and the latter, of a pleasant spring morning, while tired of eating salt stuff and canned goods, crawled up out of the water and made a meal on the first recorded salad. It looked good to him and he came back. Other members of the Saurus family got on to the snap and also came up out of the water, all sorts of long-tailed and long-billed creatures, which, to make the story short, in time became land animals. All these animals in the original balance of things not only used that land, but helped to extend its total salad-producing acres. They trampled, they spread seeds, they increased the soil products. Vegetable mould increased. The little drops of water fell on it, and plants grew again on the pleasant land. The Saurus family moved in and permanently frequented the head lettuce, cabbage and turnip greens of that day.

All went merry as a marriage bell, until, in time, Man came along. The old ways did not suit him. He began to farm, at first by means of a crooked stick, and at last by means of the Harvester Trust. Incidentally, he forgot all about the buried years, and, with skill and speed and malice which would have caused any self-respecting Saurus to blush with shame, did all he could to wreak destruction upon the forests of the earth, on the mines, on the waters, and on the soil itself. He overdrew his bank account, more in America than ever has been known in all the long, slow history either of the world or of the earth.

It would not be worth while to make here merely a series of sweeping general statements, or to make statements not definitely understandable. As it happens, the chapter and verse are ready at hand. It is entirely feasible not only to organize the waste in American soil, but to measure it. The late Professor N. S. Shaler estimated the destruction of agricultural lands, chiefly through old-field erosion, in the southern Atlantic and Gulf States at several thousand square miles; and in portions of this region the waste involves a complete removal of a superficial geologic deposit, well adapted to forming a productive soil, from underlying older formations ill suited to the development of fertile soils and subsoils, in which case the loss is irremediable.

Other estimates of soil-waste rest on the determination of soil-matter transported by our running waters. The most extensive measurements of this kind were those of Generals Humphreys and Abbott, made on the Mississippi over half a century ago. These showed that the Mississippi then carried annually into the Gulf something over four hundred million tons of solid matter, in addition to great quantities of earth-salts, carried in solution, and of sand or other coarse material rolled or swept along the bottom.

What happens when the wooded cover is removed from the land. Erosion sets in; and the land turns a bare, unsmiling face toward the sky. Vegetation can get no foothold. The world has lost some of its power to feed its people.

At the time of these determinations settlement in the Mississippi Valley was comparatively limited, and, as shown by local observations on different rivers, the effect of extending agriculture has been to *increase* the soil-matter carried by the Mississippi *fully twenty-five per cent;* while comparative determinations made on several other streams indicate that the rivers of the country outside of the Mississippi basin carry into the sea about as much soil-matter as the great river itself—that is, that the annual soil-wash of the United States aggregates fully one billion tons! Our balance of trade is going some, isn't it? Also, unfortunately, our soil, which raised that balance of trade, is going some.

A fraction of the matter transported by the waters is coarse (sand and gravel), but fully ninety per cent consists of rich soil-stuff washed from the surface or leached from the subsurface of fields and pastures and (in less degree) of woodlands. Reckoned on the basis of value as fertilizer, the material could hardly be appraised at less than one dollar per ton; so that the annual loss to the agricultural interests of the country can hardly fall short of a billion dollars—equivalent to an impost as great as most other taxes combined, and one yielding *absolutely no return.* It is worse than that. Most of us have known stocks to pass a dividend. How would you feel if the whole stock and everything back of it were wiped out? What would we think of the management that allowed such an event to happen? But this is happening, and under our own management.

The foregoing are estimates made by a United States soil expert. Other competent Government authorities can offer us definite food for additional thought, if we care to hearken. The greatest loss of our soil, we are told, is from *preventable* erosion. The total soil-wash of the country is a billion tons a year. This would make a pile of adobe as high as the Washington Monument and a *mile long* on each of the four sides! Cleared and plowed lands, the source of food products, are the ones which suffer.

Most of the soil-wash—at least seven hundred and eighty-five million tons every twelve months, probably—is dumped into the ocean and lost forever. This would fill four channels as big as the Panama Canal, according to the original specifications. So says the cold-eyed soil expert.

Four hundred million tons of soil are washed from the borders of the Mississippi and Missouri rivers and their tributaries every year and poured as mud into the Gulf of Mexico. So says the wild-eyed Washington statistician.

Muddy waters carry more impurities than clear, and so endanger health more. They have greater power for cutting away the banks of streams. Deposits in the channels, drifting sand bars and changing courses are caused entirely by *silt in muddy streams.* Had you ever thought of that? Read the hymn backward. Thrown out of balance, water and sand *un*-make the pleasant land.

From the State of Missouri alone enough soil is carried away annually to make a prism one mile square and six hundred feet high. The Missouri River bears into the Mississippi every twelve months enough earth to make a mud-pile a mile square and four hundred feet high.

The billion tons of soil which are washed away every year would spread a layer like Nile mud over Indiana, Illinois or Iowa. But what good does it do buried in the depths of the mighty ocean? It may help some future Saurus family, but it won't help yours.

Whole towns have been washed away by the change of currents in silt-laden streams. In some neighborhoods an entire farm has been taken up and carried across to the other side of a river. Within the past year the town of Pine Bluff, Arkansas, was threatened with destruction, many of the buildings toppling over into the turbid flood.

Bad plowing is the cause of a great deal of soil-waste. The farmer of America each year digs a Panama Canal with his little plow. Each year he digs out of the heart of his little forty, eighty or one hundred and sixty acres of land a block of dirt really bigger than the entire cut of the whole Panama Canal. The riches of his farm take wings. He did not see them go. He does not understand that he is literally plowing his farm into the mighty ocean. Not only do we waste, *but that waste accelerates each year.* That is the horrible feature of all these resource-wastes—they increase geometrically with awful swiftness. The buffalo went "all at once." The trees, the fish, the ore, will go "all at once." We do not like high prices, but higher prices than we now can dream

A truck garden ruined by flood. The fertile soil carried away, leaving gullies in some places and great piles of driftwood and gravel in others.

are coming to us Americans unless we can get down to a practical basis on religion, politics and business—unless we can understand that little old hymn we used to sing.

When ax and plow work together as agents of destruction and not as creative influences, then we are not using good business sense. Yet that is what we have done—ripped the covering from the soil, and then ripped off the soil itself. In that way we destroyed a primary value. In that way, also, we raised the price, cut down the supply of food, of clothes, of habitation, for the average man. The average American has let a few men steal him blind, and now he is stealing himself blind. The soil is the connecting link between organic and inorganic life. It is the foundation of organized society and of all civilization. It is not only our bank account, but more—it is the place where all the bank accounts come from.

A rich, alluvial farm, destroyed by a freshet.

Any man who touches the soil, and even the city man who does not, ought to understand it. The main truths are simple enough, like most big things. It is easy to see that depth of soil, and therefore richness in product, is inverse as to slope, because the soil washes thin on the hillsides and runs thicker on the flat. Therefore, on the flats it raises more vegetation, which in turn furnishes more mulch, which in turn holds more moisture, which in turn produces more vegetation. The great circle of the conservation of forces is a simple and beautiful thing. Slope, water supply, organic action, all these govern soil as in the days of the Saurus family. That is the Hymn of Life. Good plowing is good religion. Good politics is good religion. Good business is good religion. Good geology is good religion, too, and the circle runs around and around, beautiful and complete, if only we care to look at it in that way.

When the Government gets the little drops of water regulated in Wall street, and when we begin to understand the relation of those little drops and little grains on our farm, we shall begin to see in America the arrival of a golden age, one of growth in art, in beauty, in mentality, in altruism. Even at this stage of our development we ought to have intelligence equal to that of the average Ichthyosaurus. What Uncle Sam is trying to show us is, that without water there is no civilization, and that without proper relation of water and soil there is industrial anarchy. Bad handling of water means less crops, less soil, more polluted streams, more choked up channels, more floods, more waste and ruin, the balance of things thrown out of plumb, and the world literally turned upside-down. The Hymn of Life is one which in time the great Teacher of the Universe is going to force us to remember, whether we wish to remember it or not. It is not Washington, but the Universe, which is handing a message to us.

What, then, ought we to do to get out of the Ichthyosaurus class and to give our beneficent protective tariff something to protect? In the first place, it is not up to Uncle Sam, but up to us. Louis XVI said, "The State, it is myself!" That was in France, and some time ago. The State, it is ourselves, here in America. The remedy does not begin with your neighbor, but with yourself, and with you it begins as soon as you realize that no bank account will stand perpetual checking against it. Uncle Sam is willing to help any one of us begin the study of the soil to-day.

The soil experts of the Government are no more able to classify farms than the average farmer—every farmer knows that there may be heavy, sticky soil! thin, light, sandy soil; clay soil; open and friable mould. Any farmer knows that the great idea is to retain the natural moisture under the soil and not let it run off on the surface. The experts show that deep plowing is a good thing in certain soils, to get the water down into the earth. If the land is very flat, deep tilling may be necessary to get this surplus water out, so that the soil may drain dry and disintegrate. Most farmers know that, in a general way; but Uncle Sam can teach the average farmer a wrinkle or so as to the right balance of the little drops and the little grains.

On the hillsides which wash so badly, the soil expert says, we ought to study contour farming, as it is called. A vertical or slanting furrow will soon become a vertical gully. The horizontal furrow at the same elevation all around the hill has, on the other hand, a tendency to stop the running off of water. Great benefit, also, comes from using strips of grass land, lying in bands of the same elevation around the sides of a dangerous hill. Terracing of farms is new in this country, where we have always just gone West instead. We see the terraces of Chinese and Japanese lands, and suppose they must have been made at the expense of great labor, but in reality it was Time and Nature that made them. The soil which is washed out of the horizontal furrow is in part or in whole stopped when it strikes the edge of the grass land. In many years it banks up more and more. If not controlled it would not bank up, but simply run down the hill and fly away into the mighty ocean.

In rolling lands the canny farmer plants crops toward the tops of the hills to produce cover and mulch, and so to stop wash. He reserves some of his bottom lands for grass, to catch the soil-wash and use it. If he did not, some of his farm would run away, and not only impoverish him, but, perhaps, work injury to his neighbor. It is not good farming to farm every inch of a rich bottom. A few bands of trees would break the driving force of rain. The roots would stand against soil-wash and regulate the flooding which make bottom farming so risky in some localities. The average farmer may not believe in the sense of this, any more than the average lumberman would hesitate to cut away the forest; but the fact remains. Of course, in any very broken country, so says Uncle Sam, there should be forestry mixed with farming; otherwise, the rainfall goes off in torrents. Even Uncle Sam sometimes forgets this, for, after establishing forest reserves, he very often leases them out as sheep or goat ranges. These animals trample little paths, which soon become gullies, which, in their time, become great avenues of waste. I have seen mountains in New Mexico ruined by goats.

For fuller particulars, any anxious inquirer might do much worse than refer to the Department of Agriculture, where many of these great, slow problems are now under careful consideration. As to actual remedy, however, nothing can be done so long as we ourselves remain ignorant or careless in politics, religion and business. We must see higher than the walls of our little grooves. Also, we must see about us in our own little grooves. Waste begins on your own forty acres, right at your door. You are the unit, the individual citizen. From you it is a step up to your hundred, under the old Saxon law. Thence you go to your town, your State, your National Government. Your wish can prevail, if you like, at each and every step of that advance. You can say to that legislator who thinks of himself and not of you, that you would rather have in his place a man who stands for guarded resources, for large reserves of forests, rich soil, a proper water flow, an unimpeded navigation, for fair play all along the line. It all begins with you and me. We have a good country and a good government, but they won't run themselves. The reform of a great many things begins away this side of Washington, District of Columbia. Some of it can begin in the caucus, or the primary, or the forty-acre field. Common-sense and enforced laws now, or the piper to pay after a while—which is better?

At our present nice little industrial gait, here in America, we are burning the candle at both ends, quite regardless of the fact that when it is burnt out, it can never be renewed. Such American fortunes as were made out of theft of America's common resources must surely, one day and in some way, pay the price. But let us little fellows who have not "succeeded" in the world see to it that we keep our own hands clean.

This was a very wonderful and beautiful country. Having seen it before civilization took it all over, perhaps, some of us do not care so much for civilization as we might.

Perhaps some of us would rather be Indians and pray to Chief Mountain, or would rather have been members of the Saurus family, before there was any such thing as taxes and when potato salad was free. Yet here we are, each in his little groove, and, if we have to play the game, we ought to understand the game and know what the game is about.

At least one truth is, we don't own the soil. We borrow it. We ought to hand it over to the successor of our species in as good condition as when we asked the loan. The Saurus family played the game as fair as that with us; and the finest Sauri in the world were raised right here in the United States. Perhaps they didn't forget the hymns they sang.

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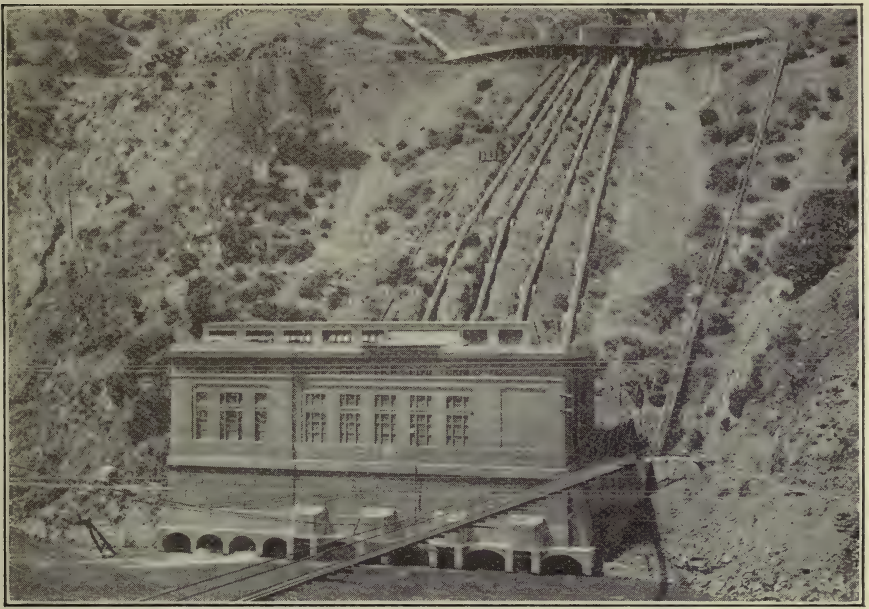
OUR WATER POWER.

Unquestionably California's greatest asset is her water power. Every year the big, round sun lifts millions of tons from the waters of the Pacific, to be carried eastward by the winds and sprinkled upon ten thousand hills and valleys in the highlands of the Sierras. Slowly it trickles downward, returning to the sea. It is gathered into rivulets, brooks, torrents, that dash faster and faster down the deep canyons and steep gorges in the western flanks of the mountains. More and more we are learning to use the power of these millions of tons as they descend from highlands to lowlands. This power is destined to be the greatest single element in the future development of the State. It is destined to turn the wheels of industry, transport people and products, light and warm the homes of the whole State. It will be an absolute necessity to life and prosperity when oil and coal are gone. Those who control it will be the lords and rulers of mankind.

Up to date our stupid laws give away this precious power forever to any one who wants it, and give him all that he wants, however much—for nothing! Thus we part with our great-grandchildren's birthright, and do not even get a mess of pottage in return. The descendants of us who foolishly part with this power now will pay tribute for centuries to the descendants of the men who get it. These Power Lords will rule over the lives and fortunes of the millions of vassals who must have the Power in order to live.



Power plant where the falling waters of Feather River give up electric current for the distant cities by the bay. Owners of power sites will be the lords and rulers of the future.

This Power should be leased, never permanently disposed of. Its title is not rightly vested in us at all. It belongs to the Future. It should never be granted to any one in perpetuity, but for a term of years, a century, if need be; but in perpetuity, never. [E. H.]

CONCENTRATION AND DEVELOPMENT OF WATER POWER.

The central fact in the water power situation of to-day is concentration of control. Ten groups of power interests control 65 per cent of all the developed water power in the United States. Some of these groups are still further related through interlocking directors between the groups themselves.

But the rapid growth of concentration and control is even more striking than the amount of it. Two years ago the ten greatest groups of water power interests controlled in round numbers 3,270,000 horsepower developed and undeveloped. To-day the ten greatest groups control 6,270,000 horsepower. Thus the amount of concentration has nearly doubled in two years.

In view of these facts, on November 20, 1913, the following amendment of the resolutions of the National Conservation Congress was passed by an overwhelming vote:

> WHEREAS, Concentrated monopolistic control of water power in private hands is swiftly increasing in the United States, and far more rapidly than public control thereof; and
>
> WHEREAS, This concentrating, if it is fostered, as in the past, by outright grants of public power in perpetuity, will inevitably result in a highly monopolistic control of mechanical power, one of the bases of modern civilization, and a prime factor in the cost of living; therefore,
>
> *Be it resolved,* That we recognize the firm and effective control of water power corporations as a pressing and immediate necessity urgently required in the public interest;
>
> That we recognize that there is no restraint so complete, effective, and permanent as that which comes from firmly retained ownership of the power site;
>
> That it is, therefore, the solemn judgment of the Fifth National Conservation Congress that hereafter no water power now owned or controlled by the public should be sold, granted, or given away in perpetuity, or in any manner removed from the public ownership, which alone can give sound basis of assured and permanent control in the interests of the people.

"BLIND MOUTHS."

An editorial from Century Magazine, November, 1907. It is a very fine example of scholarly modern English.

Literature is full of trenchant expressions of the recklessness of greed, such as "After us, the deluge!" "Devil-may-care" and "Out of sight, out of mind"—but none of them compared with the lightning-like revelation of selfishness made by these two words of Milton's. Conveying, as they do, the sense of an all-consuming appetite, the very maw of darkness, they would seem to have come from the poet's vituperative prose, rather than from the flowing elegy of the gentle Lycidas.

"What has posterity ever done for us that we should do anything for posterity?" is a saying as striking for the falsity of its suggestion as for the edge of its wit. The most obvious material and natural reasons impel us to work for posterity. Our happiness consists largely in procuring the happiness of our children and our grandchildren, whose happiness in turn will consist in the happiness of *their* children and grandchildren. However attenuated this altruistic sentiment may become with further extension, it is enough for practical purposes if it shall reach forward four generations. We bless our ancestors for the building of roads and the planting of trees and it is what posterity will do for us in the way of benediction that rightly animates any one above the beasts. Indeed, it is hardly too much to say that civilization itself lies in the fact—and to the extent—that "out of sight" is *not* "out of mind."

* * * * * * * *

It is with the conservation of the forests that we are here concerned, for without them there would be far less range to administer. Until 1890 our land policy was all steam and no brake. Under a false individualism, due to consideration for the bona fide settler and the Civil War veteran, the larger interests of the region, which included their interests, were forgotten. Recklessness and waste were rampant. By false entries, bribery, and local terrorism millions of acres were acquired and held by individuals and corporations, and what was intended for the homemaker fell into the grasp of commercial exploiters, whose operations have not only left trails of devastation, but have poisoned the politics of many states.

During Mr. Harrison's administration * * * came a new policy. By a legislative provision, passed March 3, 1891, the President was authorized to withdraw from public entry and set apart and reserve in any state or territory such portions of the public lands as might in his opinion be desirable for the preservation of the forests and waters. Then began a campaign of education throughout the country so continuous that he must be ignorant indeed who does not know the impressive reasons why the upland forests must be preserved. The lingering tragedies of those Mediterranean countries—Greece, Italy, France, Spain, and the African coast—which permitted wholesale destruction of their forests, have been rehearsed for our warning

> Till old Experience do attain
> To something of prophetic strain,

while the success of the present far-sighted policies of Germany, France, and other countries have been cited for our encouragement.

* * * The walnut and white pine of the Lake States are virtually exhausted; the leather trust is everywhere decimating the hemlock for tanbark, while the soft woods, saplings as well as larger growth, are being indiscriminately devoured by the pulp mills. Meanwhile, the senseless tariff on lumber tempts the rich companies to further depletion of our resources, rather than permit the builder to buy in the cheaper and inexhaustible market of Canada. Could folly farther go?

Reversing the witticism, let us ask, What has posterity ever done to us that we should do such things to posterity?

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WHEN THE FORESTS ARE GONE.

Teachers of geography and others interested in such matters will find a wealth of good material in a large volume by George P. Marsh entitled THE EARTH AS MODIFIED BY HUMAN ACTION. The following paragraphs give a vivid idea of conditions in certain parts of France. It is the part of wise people to profit by the experience of others, to take warning from others' misfortunes.

"When the forest is gone, the great reservoir of moisture stored up in its vegetable mould is evaporated, and returns only in deluges of rain to wash away the parched dust into which that mould has been converted. The well-wooded and humid hills are turned to ridges of dry rock, the débris from which encumbers the low grounds and chokes the watercourses, and—except in countries favored with an equable distribution of rain throughout the seasons, and a moderate and regular inclination of surface—the whole earth, unless rescued by human art from the physical degradation to which it tends, becomes as assemblage of bald mountains, of barren, turfless hills, and of swampy and malarious plains. There are parts of Asia Minor, of northern Africa, of Greece, and even of Alpine Europe, where the operation of causes set in action by man has brought the face of the earth to a desolation almost as complete as that of the moon; and though, within that brief space of time which we call "the historical period," they are known to have been covered with luxuriant woods, verdant pastures, and fertile meadows, they are now too far deteriorated to be reclaimable by man, nor can they become again fitted for human use."

"The Alps of Provence present a terrible aspect. In the more equable climate of northern France, one can form no conception of those parched mountain gorges, where not even a bush can be found to shelter a bird, where, at most, the wanderer sees in summer here and there a withered lavender, where all the springs are dried up, and where a dead silence, hardly broken by even the hum of an insect, prevails. But if a storm bursts forth, masses of water suddenly shoot from the mountain heights into the shattered gulfs, waste without irrigating, deluge without refreshing the soil they overflow in their swift descent, and leave it even more seared than it was from want of moisture. Man at last retires from the fearful desert, and I have, the present season, found not a living soul in districts where I remember to have enjoyed hospitality thirty years ago."

"It is certain that the productive mould of the Alps, swept off by the increasing violence of that curse of the mountains, the torrents, is daily diminishing with fearful rapidity. All our Alps are wholly, or in large proportion, bared of wood. Their soil, scorched by the sun of Provence, cut up by the hoofs of the sheep, which, not finding on the surface the grass they require for their sustenance, gnaw and scratch the ground in search of roots to satisfy their hunger, is periodically washed and carried off by melting snows and summer storms."—

"I will not dwell on the effects of the torrents. For sixty years they have been too often depicted to require to be further discussed, but it is important to show that their ravages are daily extending the range of devastation. The bed of the Durance, which now in some places exceeds a mile and a quarter in width, and, at ordinary times, has a current of water less than eleven yards wide, shows something of the extent of the damage. Where ten years ago, there were still woods and cultivated grounds to be seen, there is now but a vast torrent; there is not one of our mountains which has not at least one torrent, and new ones are daily forming.

"In the days of the Roman Empire the Durance was a navigable, or, at least, a boatable, river, with a commerce so important that the boatmen upon it formed a distinct corporation.

"Even as early as 1789 the Durance was computed to have already covered with gravel and pebbles not less than 130,000 acres, which but for its inundations, would have been the finest land in the province."

BEFORE AND AFTER.

Last summer I went back to visit my boyhood home in Ohio, after an absence of thirty years. One of the most striking changes in the landscape was in the *roofs* of the buildings. They were nearly all of slate instead of shingles. A shingle roof was a sign that the house was a very old one. Even the chicken houses and barns and woodsheds were roofed with slate.

For why, wooden shingles had grown so high priced that slates could be brought from a distant state to compete with them; and the shingles were all made of such knotty, brash, inferior lumber that they rotted away in a short time and were not worth putting on.

Looking further, it was plain that in thirty years the state had changed from a country of wood to a country of clay. Bricks were the universal building material. Tiles were used where bricks were impossible or undesirable. Ceramics was the most important industry of the state. The lumber is gone! The wood is no more! The trees are gathered to their fathers!

I gazed in astonishment at a vast old oaken barn than had been in the scenes of my childhood; and talked with the gray-headed patriarch who owned it. Its sills were beams of solid oak, 24 and 26 inches square, 30 and 40 feet long, and there were scores of them. Away up, high above the tall haymows, were plates and beams by hundreds, all of sound old oak and each big enough for the foundation of a great building. The whole state now would be raked in vain to find the timber for that one barn. The lumber in it would be worth a huge sum now. But the old man told me it had all been cut from the choice trees of one field, right there—and I looked afar over a bare and treeless plain.

And all Ohio was one great, shaggy forest, only a hundred years ago—dense forests of splendid hardwoods, walnut, hickory, oak, ash, maple, beech, sycamore, poplar. It was *inexhaustible*. The strong and hardy pioneers worked like slaves early and late to cut, burn, clear the land. They were sure the forests would last till the crack of doom.

Only a hundred years have passed; yet the country is bare; and every springtime now we read of the devastating floods of the Ohio; and the soil of the fertile farms continually goes to feed the yellow tides.

[E. H.]

A NEW PATRIOTISM.

This article from the World's Work Magazine is certainly worth thoughtful reading by all Americans. Don't fail to note its fine, patriotic spirit. It is by Gifford Pinchot, who has had every opportunity for twenty years to know whereof he speaks. It is said that he accepts no salary for his work as chief forester of the United States, but turns it back into the treasury for the good of the cause, and devotes the best years of his life to a labor of love.

The people of the United States are on the verge of one of the great quiet decisions which determine national destinies. Crises happen in peace as well as in war, and a peaceful crisis may be as vital and controlling as any that comes with national uprising and the clash of arms. Such a crisis, uneventful and almost unperceived, is upon us now, and unwittingly we are engaged in making the decision that is thus forced upon us. And, so far as it has gone, our decision is wrong. Fortunately, it is not yet final.

The question we are deciding with so little consciousness of what it involves is this: What shall we do with out natural resources? Upon the final answer that we shall make to it hangs the success or failure of this nation in accomplishing its manifest destiny.

Few Americans will deny that it is the manifest destiny of the United States to demonstrate that a democratic republic is the best form of government yet devised, and that the ideals and institutions of the great republic taken together must and do work out in a prosperous, contented, peaceful, and righteous people; and to exercise, through precept and example, an influence for good among the nations of the world. That destiny seems to us brighter and more certain of realization to-day than ever before. It is true that in population, in wealth, in knowledge, in national efficiency generally, we have reached a place far beyond the farthest hopes of the founders of the republic. Are the causes which have led to our marvelous development likely to be repeated indefinitely in the future, or is there a reasonable possibility, or even a probability, that conditions may arise which will check our growth?

Danger to a nation comes either from without or from within. In the first great crisis of our history, the Revolution, another people attempted from without to halt the march of our destiny by refusing to us liberty. With reasonable prudence and preparedness we need never fear another such attempt. If there be danger, it is not from an external source. In the second great crisis, the Civil War, a part of our own people strove for an end which would have checked the progress of our development. Another such attempt has become forever impossible. If there be danger, it is not from a division of our people.

Our Third National Crisis.

In the third great crisis of our history, which has now come upon us unawares, our whole people, unconsciously and for lack of foresight, seem to have united together to deprive the nation of the great natural resources without which it can not endure. This is the pressing danger now, and it is not the least to which our national life has been exposed. A nation deprived of liberty may win it, a nation divided may reunite, but a nation whose natural resources are destroyed must inevitably pay the penalty of poverty, degradation, and decay.

At first blush this may seem like an unpardonable misconception and over-statement, and if it is not true it certainly is unpardonable. Let us consider the facts. Some of them are well known, and the salient ones can be put very briefly.

The five indispensably essential materials in our civilization are wood, water, coal, iron, and agricultural products.

We have timber for less than thirty years at the present rate of cutting. The figures indicate that our demands upon the forest have increased twice as fast as our population.

We have anthracite coal for but fifty years, and bituminous coal for one hundred.

Our supplies of iron ore, mineral oil, and natural gas are being rapidly depleted, and many of the great fields are already exhausted. Mineral resources such as these when once gone are gone forever.

We have allowed erosion, that great enemy of agriculture, to impoverish and, over hundreds of square miles, to destroy our farms. The Mississippi alone carries yearly to the sea more than 4,000,000,000 tons of the richest soil within its drainage basin. If this soil is worth a dollar a ton, it is probable that the total loss of fertility from soil-wash to the farmers and forest owners of the United States is not far from a billion dollars a year. Our streams, in spite of the millions of dollars spent upon them, are less navigable now than they were fifty years ago, and the soil, lost by erosion from the farms and the deforested mountain sides, is the chief reason. The great cattle and sheep ranges of the West, because of over-grazing, are capable, in an average year, of carrying but half the stock they once could support and should still. Their condition affects the price of meat in practically every city of the United States.

These are but a few of the more striking examples. The diversion of great areas of our public lands from the home maker to the landlord and the speculator, the national neglect of great water powers, which might well relieve, being perenially renewed, the drain upon our non-renewable coal; the fact that but half the coal has been taken from the mines which have already been abandoned as worked out and in caving-in have made the rest forever inaccessible; the disuse of the cheaper transportation of our waterways, which involves but little demand upon our nonrenewable supplies of iron ore, and the use of the rail instead—these are other items in the huge bill of particulars of national waste.

The Disregard of the Future.

We have a well-marked national tendency to disregard the future, and it has led us to look upon all our natural resources as inexhaustible. Even now that the actual exhaustion of some of them is forcing itself upon us in higher prices and the greater cost of living, we are still asserting, if not always in words, yet in the far stronger language of action, that nevertheless and in spite of it all, they still are inexhaustible.

It is this national attitude of exclusive attention to the present, this absence of foresight from among the springs of national action, which is directly responsible for the present condition of our natural resources. It was precisely the same attitude which brought Palestine, once rich and populous, to its present desert condition, and which destroyed the fertility and habitability of vast areas in northern Africa and elsewhere in so many of the older regions of the world.

The conservation of our natural resources is a question of primary importance on the economic side. It pays better to conserve our natural resources than to destroy them, and this is especially true when the national interest is considered. But the business reason, weighty and worthy though it be, is not the fundamental reason. In such matters, business is a poor master but a good servant. The law of self-preservation is higher than the law of business, and the duty of preserving the nation is still higher than either.

The American Revolution had its origin in part in economic causes, and it produced economic results of tremendous reach and weight. The Civil War also arose in large part from economic conditions, and it has had the largest economic consequences. But in each case there was a higher and more compelling reason. So with the third great crisis of our history. It has an economic aspect of the largest and most permanent importance, and the motive for action along that line, once it is recognized, should be more than sufficient. But that is not all. In this case, too, there is a higher and more compelling reason. The question of the conservation of natural resources, or national resources, does not stop with being a question of profit. It is a vital question of profit, but what is still more vital, it is a question of national safety and patriotism also.

We have passed the inevitable stage of the pillage of natural resources. The vast wealth we found upon this continent has made us rich. We have used it, as we had a right to do, but we have not stopped there.

We have abused, and wasted, and exhausted so much that there is the gravest danger that our prosperity to-day will have been made at the price of the suffering and poverty of our descendants. We may now fairly ask of ourselves a reasonable care for the future and a natural interest in those who are to come after us. No patriotic citizen expects this nation to run its course and perish in a hundred, or two hundred, or five hundred years; but, on the contrary, we expect it to grow in influence and power, and, what is of vastly greater importance, in the happiness and prosperity of our people. But we have as little reason to expect that all this will happen of itself as there would have been for the men who established this nation to expect that a United States would grow of itself without their efforts and sacrifices. It was their duty to found this nation, and they did it. It is our duty to provide for its continuance in well-being and honor. That duty it seems as though we might neglect. Not in wilfulness, not in any lack of patriotic devotion, when once our patriotism is aroused, but in mere thoughtlessness and inability or unwillingness to drop the interests of the moment long enough to realize that what we do now will decide the future of the nation. For, if we do not take action to conserve the natural resources, and that soon, our descendants will find them gone.

Let me use a homely illustration: We have all known fathers and mothers, devoted to their children, whose attention was fixed and limited by the household routine of daily life. Such parents were actively concerned with the common needs and precautions and remedies entailed in bringing up a family, but blind to every threat that was at all unusual. Fathers and mothers such as these often remain serenely unaware while some dangerous malady or injurious habit is fastening itself upon a favorite child. Once the evil is discovered, there is no sacrifice too great to repair the damage which their unwitting neglect may have allowed to become irreparable. So it is, I think, with the people of the United States. Capable of every devotion in a recognized crisis, we have yet carelessly allowed the habit of improvidence and waste of resources to find lodgment. It is our great good fortune that the harm is not yet altogether beyond repair.

The profoundest duty that lies upon any father is to leave his son with a reasonable equipment for the struggle of life and an untarnished name. So the noblest task that confronts us all to-day is to leave this country unspotted in honor, and unexhausted in resources, to our descendants, who will be, not less than we, the children of the founders of the republic. I conceive this task to partake of the highest spirit of patriotism.

LEARNING FROM HISTORY.

The following is an extract from a paper by A. B. Benton, before the Tri-counties Reforestation Committee, in Southern California. It certainly affords food for thought.

The editor of one of our great weekly journals has written: "Probably the works for which President Roosevelt will be longest remembered are his efforts for the conservation of our national natural resources."

The fountains must be renewed, the field must be planted, the fire must be checked, and by us or we will justly merit the contempt of mankind. We are not the first, but the last of the nations who have squandered their birthright. The splendid nations of old time, Egypt, Babylonia, Asia Minor, Greece, India, China; where our race began its career, where the arts and letters and commerce and architecture were born and flourished in glorious achievement for centuries and centuries—do you think their lands were sterile then? Do you conceive them as poorer in lavish gifts of nature than is our land? Do you suppose the teeming millions of their inhabitants so prospered in the deserts which we find there now? Believe me, the deserts there are of men's making, and their desolation was brought about by their own hands. We look on the poor ruins of these once mighty empires with a complacent pity, but I have little doubt that the spirits of the men of old, if they are cognizant of our doings, have greater reason for a scornful pity than have we, for they began civilization and had little before their time to take warning, while we, latest of all, I verily believe have been as reckless as any of the great nations, ancient or modern.

There are many, even in this day, who can learn nothing from history for their own profit. The world of men for thousands of years has been experimenting with civilization of higher and lower types. Enough of their experiences have been written to teach us every lesson we need to learn had we the wit to read them aright. The treasures of ancient and medieval research, their economics and philosophy have been opened to this age a thousand fold more widely than to any age whatsoever before us. If it, with the histories of the good and bad of all ages before it, not in dead languages, nor locked in secluded temples and cloisters, but in its living tongues, and in multiplied libraries—if, with all this before it, it follows the blunders and mistakes and follies of the old ages because it will not see, and seeing learn, then our civilization deserves not only to perish as miserably as the most miserable failure of them all, but will richly merit the epitaph of Justice Dogberry to "be written down an ass!"

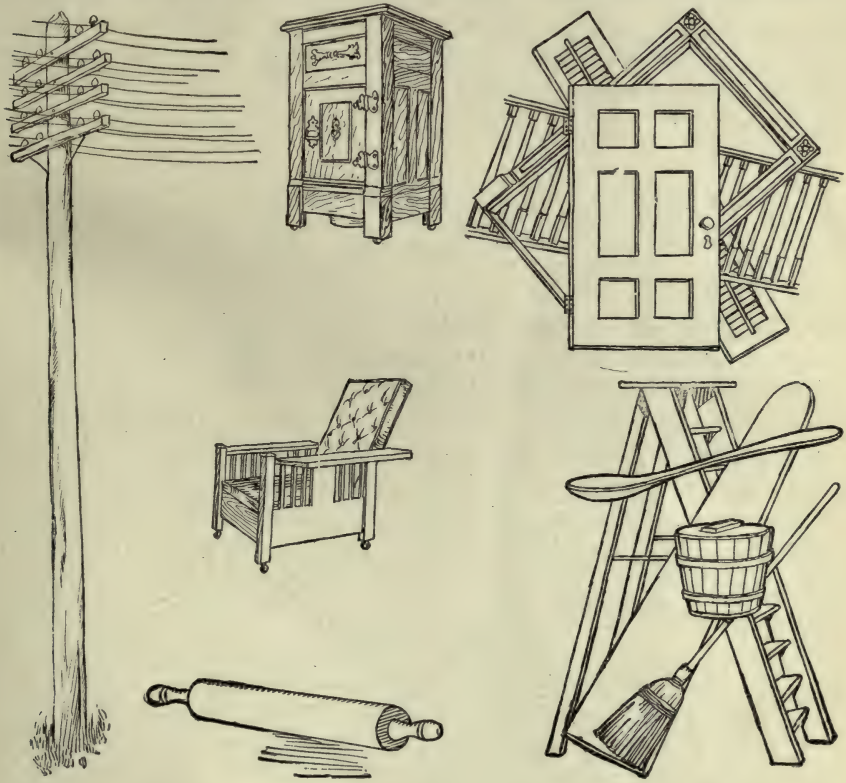
We voters of America are the bankers of the nation's resources. Infinitely more valuable is our trust than that of money, stocks or bonds, because once dissipated, it may not be replaced. If we are to preserve for our children the heritage we received from our fathers, we must alarm the people out of their thoughtless indifference. Public thieves must be punished, fires must be checked, individual rights must be purchased when demanded for the public good. Wantonness of waste by careless owners and destructive greed for immediate gain by selfish owners must be controlled. This is a mighty task, more difficult than some of the greatest our ancestors performed in the old days. But if it be not accomplished, the shame of defeat will rest on this generation, for this is pre-eminently our battle. We may not throw its burden backward to our fathers, or forward to our children. The former could not see its swift coming, the latter will have little to fight for if we fail in preserving for ourselves and them the resources by which only we or they can win continued prosperity.

THE CITIES, TOO.

The following appeared only a few days ago, an editorial in a San Francisco newspaper. The accompanying pictures show some of the common articles that must double, treble, quadruple in price as wood grows scarce.

The Government's efforts to save the country's forests are impeded by the fact that the city man, who holds the balance of political power, is apt to think that the woods have nothing to do with him. This is a mistake, of course, and is worth pointing out.

It is true that spinach and spring chickens do not grow on forest trees, and that such things come to the city market without much regard to political opinions. But the preservation of the country's great natural resources of wood and streams is a political issue. And at this point our cockney ignorance and complacency need to be pierced by sane rays of light from the rural world.



In point of fact, the wood supply is next in importance to the food supply. It is probably more indispensable than the supply of iron or coal.

The cost of living—and consequently the standard of living to which city people of ordinary incomes can aspire—is seriously affected by the state of the wood supply.

In view of such considerations no San Franciscan should read with listless eyes such statements as those contained in a recent bulletin of the National Forest Service.

We learn by this document, for example, that an average American citizen uses up in a year seven times as much wood as a citizen of Germany. And we are told that Americans produce on an acre of woodland only a quarter as much as the Germans do.

We are assured by our Government experts that there is no natural reason why we shouldn't grow as good crops of trees in this country as are grown anywhere in Europe. And it is plain that the improvement and perpetuation of the wood supply is a matter of public education—in which city people are bound to bear a leading part.

* * *

NATIONAL FORESTS AND NATIONAL PARKS.

The forest policy of the U. S. Government is of interest to every citizen. Henry S. Graves, the present forester, has this to say in his report for 1913.

The fundamental aim in administering the National Forests is to develop their resources for the permanent upbuilding of the country. The whole object of their administration would be defeated by closing the forests to development and maintaining them as a wilderness. The aim of administration is essentially different from that of a national park, in which economic use of material resources comes second to the preservation of natural conditions on esthetic grounds. When National Forest land occurs which is chiefly valuable for agriculture, its free homesteading not only aids local development and advances the general public welfare, but also directly helps in the administration and development of the forests themselves. The upbuilding of agriculture in the forests where agricultural land occurs is on a par with the building up of industries through the use of timber, forage, and other resources of the forests. The National Forests can not be developed properly without people. The usefulness of the forests is in direct ratio to the number of people who use their resources. The presence of developed farms within the forests aids in fire protection. Every cleared strip is a fire line; every ranch is a vantage point for fire fighting; every rancher may be made a forest protector. It is, therefore, the aim to further the agricultural development of all land which may be better used for growing field crops than for growing trees. Further, it is the aim and duty of every forest officer to aid settlers in the forests in the development of their farms by allowing free use of timber for domestic purposes, and in other ways.

The aims of the forest policy are:

To prevent losses of this public property by fire.

To utilize the ripe timber which can be marketed.

To cut the ripe timber in such a way as to insure restocking of the land and the continuance of forest production.

To sell ripe timber at a price representing, as required by statute, the appraised market value and a proper return to the public which owns it.

To sell ripe timber in such a way as to prevent its speculative acquisition and holding.

To prevent monopoly of public timber and to use it as far as possible to maintain competitive conditions in the lumber industry.

To provide first for the requirements of local communities and industries, including free use and sale at cost to settlers as authorized by statute.

To make timbered lands of agricultural value available for settlement, under conditions which prevent speculative acquisition but encourage permanent and genuine farming.

To return as soon as possible the cost of protection and administration and to yield a revenue to the states, which are entitled by statute to 25 per cent of all gross receipts as an offset to the loss of local taxes through Government ownership of the forests.

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SOME ASPECTS OF FORESTRY.

By Treadwell Cleveland, Jr.

Many people in this country think that forestry had never been tried until our Government began to practice it upon the national forests. Yet forestry is practiced by every civilized country in the world, except China and Turkey. It gets results which can be got in no other way, and which are necessary to the general welfare. Forestry is not a new thing. It was discussed two thousand years ago, and it has been studied and applied with increasing thoroughness ever since.

The principles of forestry are everywhere the same. They rest on natural laws, which are at work everywhere and all the time. It is simply a question of how best to apply these laws to fit local needs and conditions. No matter how widely countries may differ in size, climate, population, industry, or government, provided only they have forests, all of them must come to forestry some time as a matter of necessity.

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The countries of Europe and Asia, taken together, have passed through all the stages of forest history, and applied all the known principles of forestry. They are rich in forest experience. The lessons of forestry were brought home to them by hard knocks. Their forest systems were built up gradually as the result of hardship. They did not first spin fine theories and then apply those theories by main force. On the contrary, they began by facing disagreeable facts. Every step of the way toward wise forest use, the world over, has been made at the sharp spur of want, suffering, or loss. As a result, the science of forestry is one of the most practical and most directly useful of all the sciences. It is a serious work, undertaken as a measure of relief, and continued as a safeguard against future calamity.

Planting crew at work in Sierra National Forest. The men are planting sugar pine seeds with hoes on an area that has been repeatedly burned for fifteen years.

Roughly, those countries which to-day manage their forests on sound principles have passed through four stages of forest experience. At first the forests were so abundant as to be in the way, and so they were either neglected or destroyed. Next, as settlements grew and the borders of the forest receded farther and farther from the places where wood was needed and used, the question of local wood supplies had to be faced, and the forest was spared or even protected. Third, the increasing need of wood, together with better knowledge of the forest and its growth, led to the recognition of the forest as a crop, like agricultural crops, which must be harvested and which should therefore be made to grow again. In this stage silviculture, or the management of the forest so as to encourage its continued best growth, was born. Finally, as natural and industrial progress led to measures for the general welfare, including a wiser and less wasteful use of natural resources, the forest was safeguarded and controlled so as to yield a constant maximum product year after year and from one generation to another. Systematic forestry, therefore, applied by the nation for the benefit of the people, and practiced increasingly by far-sighted private citizens, comes when the last lesson in the school of forest experience is mastered.

Converse Flats Nursery in the Angeles National Forest showing a forester transplanting seedling of Jeffrey pine for reforesting.

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China holds a unique position as the only civilized country which has persistently destroyed its forests. What forestry has done in other countries stands out in bold relief against the background of China, whose hills have been largely stripped clean of all vegetation, and whose soil is almost completely at the mercy of the floods. Trees have been left only where they could not be reached. Almost the sole use for lumber now is the manufacture of coffins. The heavy two or three inch planks for this purpose are so scarce, and the cost of transporting them by coolies is so high, that they sell for $2.00 or $3.00 apiece.

Nowhere in the world is the forest cleaned off down to the very soil as it is in China. When the trees are gone, the saplings, the shrubs, and even the herbage are taken. Slender poles are used to build houses; inconsiderable shrubs are turned into charcoal. In the lower mountains of northeastern China, where the stripping process has reached its extreme phase, there is no trace of anything worthy of the name of forest. In the graveyards and courts of the temples a few aged cedars have been preserved by the force of public opinion, and poplars and fruit trees planted about dwellings are protected as private property by the peasant owners.

In the province of Shantung, where deforestation is practically complete, fuel and fodder for cattle are literally scratched from the hillsides by boys who go out from villages with their iron rakes in autumn to secure winter supplies. Grazing animals, searching every ledge and crevice, crop the remaining grass down to the very roots.

In the Sierra National Forest. The ranger's horses are waiting for their master. Notice the boards nailed on the trees high overhead. They mark the depth of the winter snows, and show which way to go when the landscape is smothered by its wintry blanket.

A dearth of wood is not the only forlorn result of forest devastation—a dearth of water and the ruin of the soil follow in its train. In western China, where forest destruction is not yet complete, enough vegetation covers the mountains to retard the run-off of the rains and return sufficient moisture to lower levels, where it can be reached by the roots of crops and where springs are numerous. But on the waste hills of eastern China the rains rush off from the barren surfaces, flooding the valleys, ruining the fields, and destroying towns and villages. No water is retained at the higher levels, so that none is fed underground to the lower soils or to the springs. As a result, even on the plains the water level is too far beneath the surface to be used. Without irrigation and the ingenious terracing of hillsides, by which the rains are made to wash the soil into thousands of miniature fields whose edges are propped up by walls, agriculture would be entirely impossible. Even irrigation calls for the immense labor of drawing the needed water from wells.

In a word, the Chinese, by forest waste, have brought upon themselves two costly calamities—floods and water famine.

* * *

OUR NEIGHBOR'S FORESTS.

The Government of British Columbia has put into forest reserves at one strike a hundred and fifty million acres—five eighths of all the land in the province. In British Columbia the lumberman who wishes to cut trees must deal with the Government, whose enlightened policy, giving the people the control of their timber resources, is carried out by the local government of the province, unlike some of our western states, which hang back in sullen protest while salvation is forced upon them by a distant national authority.

* * *

CONSTRUCTION VS. DESTRUCTION.

There are nineteen National Forests in the State of California. It is a good thing to devote more time and energy to the wise and careful use of the forests that remain to us than to lamenting those that have been destroyed. Forester Graves has this to say of our present resources in pasture:

''The forage resources of the National Forests contribute in greater or less degree to the maintenance of over 20,000,000 head of domestic animals. The annual products of these animals amount in value to many millions of dollars and constitute a very large proportion of the meat supplies of the Nation. There is not a state in the Union whose demands for meats, hides, or wool are not met, in part at least, by the products of animals that have grazed upon National Forest lands.

''With each succeeding year the western stock grower places an increasing degree of dependence upon the forest ranges. The value of cultivated forage products has risen more rapidly than the price of meat. The unreserved public lands have been impaired in value by overstocking; their use for pasturage has been greatly complicated by increasing homestead settlement; their possibilities for the production of high-grade stock at moderate cost are poor, at least under existing conditions. Private grazing lands are in strong demand at prices undreamed of a few years ago. The National Forests furnish abundant supplies of forage, opportunity for the adoption of the most advanced methods of operation, freedom from epidemics fatal to live stock, and adequate protection in the enjoyment of all rights and privileges, all at a price from 50 to 75 per cent below the prevailing charges for comparable privileges on private or state lands. To the average citizen, concerned over the rapidly dwindling supply of meat products and the alarming rise in prices, the system of range management followed by the Forest Service offers greater hope of relief than any other single factor."

Logging under proper principles of forestry. The young trees are uninjured, the brush is piled for burning, some heed is taken to the future.

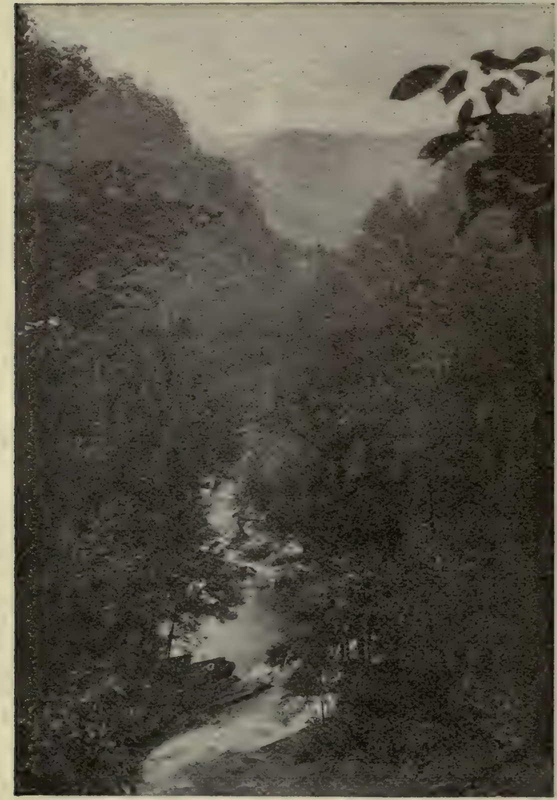
THE VITAL TRUTH.

Stewart Edward White, the noted writer of camping and outdoor stories, lives in Santa Barbara. Even his honeymoon was spent in the open, in a horseback trip through the high Sierras round about Mount Whitney. He has written a fine article for the American Magazine for January, 1908, under the caption THE FIGHT FOR THE FORESTS, from which the following is extracted, by permission.

"When a man makes his camp in the wilderness he hunts first of all two requisites. If they exist in abundance, he is happy and comfortable; if they lack, he must take his rest, and move on to more favored localities. These two requisites are wood and water.

How the forests of our high mountains hold the snowfall, preventing its sudden melting, to the destruction of the country below by flood.

And, curiously enough, these two necessities of man's abiding depend absolutely one on the other. Without rainfall the forests will not grow. Without the forests the rainfall is destructive, rather than beneficent. In a naked country—whether artificially or naturally so—the water comes in great torrential floods followed by droughts. A covering of forest, on the other hand, retains the rainfall as would a sponge, distributing it slowly through regulated streams, holding it back against the needs of the dry season. Wherever the forests have been cut away, we are treated each spring to destructive floods, as has been many times proven in the valleys of those great rivers draining the sites of the old pine forests in the East. Contrariwise, in California, where the necessities of irrigation cause the people to pay great attention to such matters, it has been found by actual measurement that the stream-flow has increased twenty-five per cent since the establishment of efficient protection for the forest cover.


How the forests hold back the water and check the floods and keep the streams from washing their banks away.

Since these things are so, it follows naturally that sooner or later nations would see through the haze of immediate expediency to the vital truth, force home boldly on the individual camper.

From this realization would come a system of forestry.

In Switzerland we find the earliest intelligent treatment of the question. Switzerland's mountainous situation would have rendered her peculiarly liable to complete extinction by flood, avalanche and the erosion of the agricultural soil, once the natural protection was removed. But to-day Switzerland is prosperous and very much alive. Over one thousand years ago she possessed a forest system, and had developed a scientific forestry by the fifteenth century. As early as Louis XIV, France awoke to the fact that her forests and her life were draining away together. But it was too late. To-day she is spending $34 an acre to reforest her watersheds. The same experience is costing Italy $20 an acre. Italy is not a wealthy nation; yet she is appropriating cheerfully this enormous sum in the realization that on it depends the question as to whether or not she will

A hill that has lost its wooded cover, and is therefore losing its soil by erosion. Nothing here to check the floods, or hold back the life-giving water.

This mountain slope was logged over many years ago. Observe that it does not reproduce forest cover, but remains a bare, parched region, at the mercy of sudden flood and summer heat.

have to strike her tents. If we of the United States were called upon to replace at even Italy's figure the trees now growing on the watersheds protected by our reserves, we should have to spend about three billion dollars!

Only a few years ago the forest was our enemy here in America. Every step of the way must be cleared by the pioneer's axe and guarded by his rifle. A tree was a foe to be got rid of as expeditiously as possible. To ingrained and inherited hostility succeeded indifference, which is but just beginning to yield ground to a more enlightened sentiment. This enlightened sentiment further encounters determined and unscrupulous opposition from the land-grabbers, the lumber stealers, the candidate for free grazing, and all the rest of the various pirates and parasites that prey upon and cling to the rich spoils of our public domain.

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A CONTINENT DESPOILED.

Rudolf Cronau is a well-known artist and writer, of German ancestry. Under the above title he has written a vivid article in the American Magazine for April, 1909, with the following introduction:

On my writing-desk lies a pile of photographs, some taken with my own camera, some obtained from friends or through the courtesy of the United States Forest Service and the Geological Survey. Besides, there are maps and papers covered with statistic figures.

If you look over this collection, you will be struck with horror, for these views disclose scenes so repulsive, that, if they were not photographs, you would believe them products of the sickly brain of some artist like the famous Belgian painter Wuerz, or the Russian Wereschagin, who, with cruel pleasure, indulged in portraying only the most unpleasant and disgusting scenes of this world.

Let us take up a few of these photographs.

Here we have the gloomy view of a forest destroyed by fire. As far as the eye can penetrate the picture, you see hundreds and thousands of straight black trunks, pointing as so many big needles toward heaven. There is not a limb left on one of the trees. Every branch is eaten away. And not a living thing is seen in this dreadful wilderness, nor will anything flourish there for years to come.

This second picture discloses another scene of devastation; a primeval forest as it was left by lumbermen after they had taken out the choice timber. What reckless barbarians these men have been! Everywhere we see the unmistakable evidences of frightful waste. The ground is covered with fragments of noble trees, and with young saplings crushed to pieces by fallen timber.

The next photographs show deforested hillsides and farm lands, damaged by rainstorms which gnawed deep gullies into the naked ground and carried away all fruitful soil. And here we have villages and cities suffering by the flood of rivers. The water reaches into the first and second stories. Mills and houses have been swept away and landed on distant places.

After that we look into a bird's nest, in which we see a heap of young birds, dead from starvation. Another of these ghastly photographs affords a glance over rocky shores, strewn with the putrid bodies of thousands and thousands of seal pups, who perished while waiting in vain for the return of their slain mothers.

And then we see horrible views showing long rows of human corpses, distorted by explosions, burned by fire, crushed by fallen rocks, or maimed by railway engines or street cars.

There are dozens and dozens of such repulsive photographs. If thrown as lantern slides upon a screen and explained by a lecturer, this collection of views, maps, and figures would cause a cry of terror among the panic-stricken audience, and many, shocked to the bottom of their hearts, would leave, never to forget that horrible exhibition.

You ask where these photographs have been taken and what the whole collection means. As an American citizen, I feel ashamed to say that all these views, without exception, were made from actual scenes in the United States, and that, together with the maps and statistic tables, they are incontrovertible and convicting evidences of grave sins of which our nation is guilty. Some of the material has been used in preparing my little book, "Our Wasteful Nation," which is not an outcome of yellow journalism, dealing in sensations, but the honest work of a man who loves this country fervently as any native-born American, and who is inspired by the wish to help it along, that it some day may gain the proud title, the best among all lands.

Perhaps native-born American writers are so accustomed to the extravagance of American life, that they fail to see the amazing amount of our prodigality, which to the stranger becomes evident at once.

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THE WATERFOWL.

Another of California's resources that is being rapidly gathered to its fathers is the wild game, particularly the waterfowl. A few years ago they seemed as "inexhaustible" as the leaves on the trees. But now 100,000 licenses to hunt are taken out in a year. If each of these guns should bring down the limit for only one day, it would mount up to a total of millions. In the Sacramento Valley four men have killed 700 geese in a day. The ''bull hunters'' of Merced County often kill over a hundred ducks at a single discharge. Nearly every day during the hunting season at Los Banos a drayload of ducks goes away by express, packed in gunny sacks, the legal limit—35 ducks—in each sack.

Of course, this valuable resource will soon disappear under such onslaughts. Of course, the ''Game Hogs'' should be suppressed, the game commission should be upheld, the laws should be enforced, so that wild fowl will not entirely disappear from our inland waters.

The same things may be said of our fishes. It does not seem possible that so delicious and valuable a fish as the salmon would be killed and used for such gross purpose as fertilizer; yet in the early days of the northwest the farmers planted a splendid salmon under each hill of their hop fields, to enrich the soil. In 1906 the Alaska Guano Company converted 18,000 barrels of salmon and 33,500 barrels of herring into fertilizer and sold it.

The heroic efforts of the Fish Commissioners can hardly hope to keep pace with the reckless and illegal fishing of the fish hog and the market fisherman. [E. H.]

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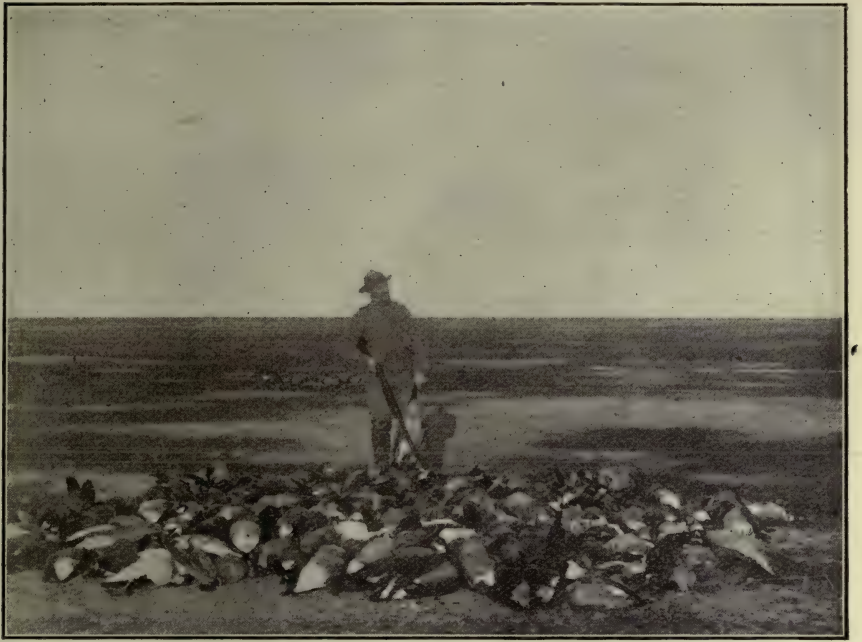
FUTURE OF MAN IN AMERICA.

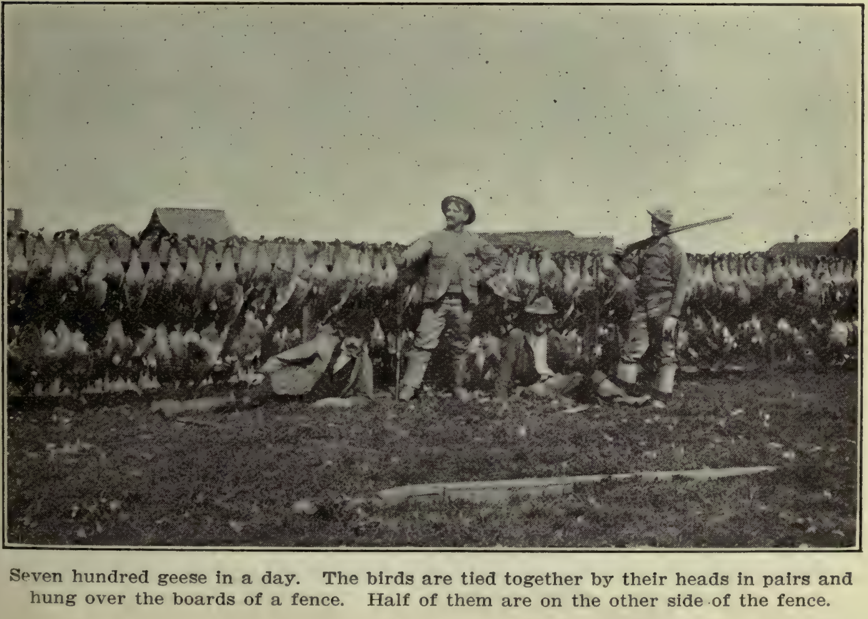
One of the wisest and best informed men of our country is President Van Hise of the University of Wisconsin. Since this work has been in press (June, 1909) he has printed in the World's Work Magazine a comprehensive article on Conservation, which closes as follows:

''It would be interesting, but idle, to prophesy as to the changes in our social structure which will result when people begin to be pinched by meager soil, by lack of sufficient coal and wood. The people of that time will doubtless solve their problems as best they may, and any speculations we might make at this time would certainly be far from future realization, but that the problems of pinching economy will confront our descendants is beyond all question; and, therefore, the paramount duty remains to us to transmit to our descendants the resources which nature has bequeathed to us as nearly undiminished in amount as is possible, consistent with living a rational and frugal life. Now that we have imposed upon us the responsibility of knowledge, to do less than this would be a base communal crime.''



A single gunner and his kill.

In the lowlands of California it is often said that a man can kill so many birds he "can't get them all in one pile."



Seven hundred geese in a day. The birds are tied together by their heads in pairs and hung over the boards of a fence. Half of them are on the other side of the fence.

A PRACTICAL VIEW.

From an article by H. Von Schon, a hard-headed working engineer, in Engineering Magazine, October, 1908.

"A bare, hard-baked surface absorbs but little water; a forested area with its deep layer of leaves, brush and humus is a sponge which becomes saturated with the water; it is a natural storage reservoir. The rapid storm surface run-off erodes the top soil and carries it in suspension, dropping it somewhere in the lower channels; timbered slopes obstruct this surface run-off; it gathers force but slowly; it finds in loose earth or gravel to carry along; the foliage canopy of the trees breaks the force of the downpouring rain, which reaches the ground gradually; finally, the snowfall on the open hillsides melts quickly under the influence of the wind and the sun, while that in the forest remains to melt gradually and then to sink into the ground.

"That water waste with its collateral flood destructions of life and property, the constantly increasing erosions of the fruitful top soil, and the consequent impoverishing of what remains, and the sedimentation of river channels, are primarily caused by the cutting away of the forests in the headwater regions of rivers, was recognized and acted upon by some of the European peoples hundreds of years ago; little Switzerland enacted a forest-conservation statute as early as 1680, which has been enforced in a most business-like manner since; 20 per cent of the mountain republic's area is in conserved forests, some 2,000,000 acres; the cost of maintenance and supervision is $1.32 and the net revenue, $2.25 per acre annually.

"Germany's forest area is 35,000,000 acres; its system of forest preservation was inaugurated one hundred and fifty years ago. France has 23,000,000 acres of forests, all under admirable preserve laws. The combined population of these two countries exceeds that of the United States about 15,000,000. They now expend annually on forest preservation some $11,000,000 and enjoy a net revenue of about $30,000,000, while the United States forestry expenditures last year aggregated $1,400,000 and the revenue $130,000."

* * *

CALIFORNIA TAN OAKS.

One of the most shocking sights in the waste of the fuel resources of this State is the method of harvesting tanbark. Thousands of square miles of our north coast region were covered by fine oak trees. To get the bark the trees are first cut down and then peeled. The bark is taken out by wagons or pack animals and sold by the cord. But the trees themselves—the massive trunks and limbs—are left to rot unseen in the undergrowth or to feed a forest fire. Millions of feet of solid oak timber were thus destroyed every year. The lumber corporations, in buying up timber land, figure the oak trees in *cords of tanbark*—the trees themselves count as nothing. The profit on the bark is not large, as it takes a deal of labor to get it out. [E. H.]

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THE SLAUGHTER OF THE TREES.

[Copyright, 1908, by the Ridgeway Company.]

Part of a striking and vivid article by Emerson Hough in the May number of Everybody's Magazine. Its startling statements appear to be substantially correct. Everybody's has kindly given permission to use this article and several of the pictures accompanying it.

In fifty years we shall have whole states as bare as China. The Appalachians will be stripped to bedrock. The Rockies will send down vast floods, which can not be controlled. The Canadian forests north of the Great Lakes will be swept away. Our Middle West will be bare. The Yazoo Delta will be ripped apart, because no levee will be able to stand the floods of those days. We shall be living in crowded concrete houses, and at double the rent we now pay. We shall make vehicles of steel, use no wood on our farms. We shall pay ten cents for a newspaper, fifty cents for a magazine, as much for a lead pencil. Cotton will be immensely higher. Beef will be the privilege of the few. Clothing will cost twice what it costs to-day. Like Chinamen, our children will rake the soil for fuel or forage or food. We shall shiver in a cold, and burn in a heat, never before felt in this temperate zone, meant by God as a comfortable growing place for splendid human beings—UNLESS WE WAKE UP.

My friend, yesterday a man took the meat from your table. To-day a man burned down your house. Do you care?

My friend, yesterday this was America, a rich and beautiful land. To-day much of it is a waste and a wilderness. Is that anything to you and me?

My brother, in ten years a man is going to force you to rent a house of him, and to pay double what you do now. In twenty years very few of us will be able to afford even rented houses. In thirty years America will no longer be able to build houses of wood—unless you shall, meantime, remember that you own America, you who found it, fought for it, and who ought to have a pride in it, if only for the sake of what it might have been. Does this cause you any personal concern?

My friend, before a certain great revolution, the peasants who could not own timber of their own, gleaned firewood in the forests of nobles, who swept their backs with the lash of insolence. In England men once prized the scant right to reap with peasant's billhook or shepherd's crook as high as they could reach among the dead branches of the trees. Soon you will perhaps fight among your kind and kin for the right to glean in another man's forest by hook or crook—you, who but now owned the widest and richest forests in the world. Do you care?

In Europe one may not fell a tree without paying, without asking. As Americans, we laugh at such restrictions. We are fools. Do you care? We call this the land of the free. It is not such now. We boasted of our land of opportunity open to all the world, but opportunity has been taken from the average man. Do you object?

Do you think such statements as these sensational, brutal, coarse? My brother, what pen shall be so bitter and abominable as shall make you writhe and say, "This is not true," and then make you look around and find that it all is true, and more is true?

When we first owned this country, one half of its total area was covered with the grandest forests that ever grew in any portion of the world—the richest, the most useful, the most valuable for the building of a civilization. Yes, we had trees. We had forests that set the first writers who saw this county wild with admiration, men who came here from reforested Europe. They were all ours. Now they are gone. Are they reared in lasting structures of a great civilization? No; at least one half of them are ashes or rotted mould. Half of what we have left to-day also will be ashes or rotted mould. They will never rest in the beams and walls of abiding homes.

Had we gone on across this continent and left the remnants of our standing woods, we still should have abundance; but we have gone back a second and a third time, gleaning more exactly each little bit of wood, until we have reaped our forests as sheep reap the grass lands, leaving nothing behind to grow. We have used ever-increasing appliances for speed and thoroughness, to supply an ever-increasing demand, at all ever-increasing price. We are converging in ever-increasing numbers, with an ever-increasing zeal, upon what is left; and in our haste to get it all, we are permitting an ever-increasing waste and ruin of the original supply.

Our very classification shows how sweeping has been the devastation. We now classify as "pine" all sorts of pine—Norway pine, Jack pine, pitch pine—although we know that true white pine, once the only wood dignified with the name, is, as a great lumber tree, practically an extinct species. As to the hardwoods, twenty years ago we used only oak, walnut, hickory, cherry, maple, birch; now we add cottonwood, beech, sycamore, all sorts of gum trees, anything that will saw into a board. The desolation in the hardwood forests of the South is as unspeakable as in the pine forests of the North. Stave-makers, tie cutters, vehicle and machinery makers, have ripped open the hardwood regions of Tennessee, Mississippi, and Arkansas, until the end is as close there as it is in the vaster pine woods.

On the Pacific coast we used not long ago only the finest of redwood, gradually then the Douglas fir or spruce. Now we cut in the West hemlock, cedar, lodge-pole pine, anything that will hold a saw blade. For a long time we thought these great Western stores exhaustless, just as not long ago we thought the forests of Michigan and Wisconsin exhaustless, where now remains in great part only a horrible wilderness.

All the time poorer species and grades of timber are employed all over America, East and West. All the time the "estimates" of our remaining timber increase. But all the time the standing trees themselves decrease; all the time the fires rage; all the time the waste goes on, immense logs, the butts of giant trees, being left in the woods to rot because it does not pay to get them out of the woods "at the present price of lumber." All the time the loss to the people of America goes on, and the price to the people of America goes up; and all the time the people of America either do not know or do not care.

We ought to care, and if we know the facts no doubt we should care. What, then, are some of the facts? Plenty of facts, and very obvious ones, lie at hand for any one interested in any sort of building or manufacture requiring the use of lumber. What was $8 or $10 is now worth $25 to $30 a thousand. Ordinary clear building and finishing lumber costs from $30 to $125 a thousand. The price of all lumber has in five years risen over fifty per cent. We use lumber now that twenty years ago would have been rejected with scorn by any builder. Yet prices are going up, and still up; and the lumbermen wish these prices "protected," and ask that the Sherman law be revoked. In spite of these facts, the professional optimist in lumber attempts to soothe us with the assurance that there is plenty of timber "farther west"; that it will last "indefinitely" at the "present rate."

But the lumberman bases all his timber estimates on the present rate of cutting and on the present rate of demand. True, no one can prophesy or estimate the accelerated, the cumulative demand of the future. Decade after decade of our past has shown us that we could not dream big enough to cover the actual figures of this demand. Yet this unestimated factor is the element of danger for the future.

The lumberman does not figure on the million or more of immigrants we take in each year to house, not to mention an occasional American native born. Worst and most absurd of all, he figures on the timber supply lasting on the basis of its all being used. Yet of all the timber now left standing in America, to represent our entire future supply, this lumberman, judged by his record, will use less than one half. The other half will never be taken out of the woods at all. Three fourths of that half may never even be cut, but may be set on fire and burned as it stands. Much as we had in forest resources in the past, we never could afford to have lumbering operations destroy as much as they sawed. But that is what they did. What should be our attitude to-day toward the threatening destruction of one half of our alarmingly small remaining supply?

Last year we cut nearly forty billion (40,000,000,000) feet of lumber, board measure. It may be interesting to know in what proportions the different states furnished this supply. In relative order a partial list is as follows: Washington, Louisiana, Wisconsin, Michigan, Mississippi, Arkansas, Minnesota, Texas, Pennsylvania, Oregon, California, North Carolina, and so down. To-day Washington furnishes 11.5 per cent of our lumber, and Louisiana 7.4 per cent. Let us look now at some of the demands for trees that at first might seem unimportant.

Our railroads are said to use one third of the industrial timber cut. They require, on the basis of present demand, 100,000,000 ties per year, and they are always wondering where they are going to get them. The demand is for better ties, not poorer. Bad ties mean wholesale murder, forfeiture of mail contracts, reduced dividends. A tie contains about thirty-five feet of wood. All sorts of wood are now being used for ties, from hemlock at twenty-eight cents to white oak at fifty-one cents, an average of forty-seven cents per tie. Suppose we could cut one hundred ties to the acre; we should require a million acres a year for ties. Hardwood grows, under favorable conditions, a little more than forty cubic feet per acre per year. Not a very fast crop, is it? Railroad men sincerely wish it might be faster. The Santa Fe road has recently arranged to plant a few thousand acres with eucalyptus, from which it will some time make ties. Each road now has its tie lands. These lands no longer furnish a public supply of lumber.

Alongside the ties run the telegraph poles, not so perishable, but requiring continual renewal. Two years ago we cut 3,526,875 poles over twenty feet in length. Three fifths of these were cedar, 28 per cent chestnut. We cut hundreds of thousands of smaller poles, also, not to mention vast quantities of what is called lodge-pole pine, for other uses. We annually reap for telegraph and telephone poles somewhere between three and four million acres of land.

Our tanneries two years ago required 1,370,000 cords of bark. In the same year we cut 11,858,260 shingles and 3,812,807 laths. This represents one of the real savings in lumber manufacture—the utilization of material much of which otherwise would go to waste. Then we had to timber our mines, and for that we used 165,000,000 cubic feet, not board measure, much of which was the best of hardwood.

If you stood on the top of a tower in the greatest hardwood forests of the South, one sweep of the scythe of civilization would mow it farther than you could see, for one month's use in vehicles, manufactured furniture, and farm implements. Prices for this kind of wood have risen from 25 to 65 per cent since 1899. In seven years the production of hardwood has fallen off 15 per cent; and those were the six years of its greatest demand.

There is absolutely no hope for vehicles and machine makers except a more careful use of the hardwood forests of the South and the Southeast; nor indeed can that be called a solution now. In these forests grow also many softer woods, once scorned. Continually we adjust, compromise, become European and not American. Tight-barrel cooperage is a heavy drain on white oak. In 1906 we made 267 million tight-barrel staves. We sent to Europe last year about five million dollars' worth of white oak staves. Meantime, California can not get casks for her wine, because white oak now costs too much to ship to California. She is trying redwood for wine casks now, and grumbling mightily. Slack-barrel cooperage in elm, gum, beech, basswood, and fourteen other woods not long ago thought worthless, cut 1,097,063,000 staves in one year. All these little demands foot up an enormous and menacing total in acreage.

Waste of timber in the Yellowstone Park. Our descendants will bitterly rue this loss.

The highest estimate of our remaining hardwood is four hundred billion feet. For lumber, ties, posts, manufactures, fuel, etc., we use twenty-five billion feet per annum or more. At that rate it will take us sixteen years to use up all the rest of our hardwood—if we do not burn it, and if the demand remains the same! A pleasant prospect, is it not?

Some one has figured that a big Sunday newspaper needs twenty acres of pulp wood to make the paper for one edition. The Chicago Tribune, a chance instance, uses 200,000 pounds of paper each Sunday, or 400,000 each week. Do your own multiplying. We used of domestic spruce alone for pulp wood in one year 1,785,680 cords. The average stand of spruce pulp wood in the regions where it is cut is probably about ten cords per acre; so that of such spruce land we require at least 178,500 acres annually. A ton of paper takes about two cords of spruce in the making—to be exact, about 1,750 pounds of paper pulp.

We use other woods for pulp now, hemlock, balsam, pine, poplar; 3,661,176 cords was our total for 1906. We used in that year 2,327,844 tons of pulp. Since each ton probably cost on the average two cords of some sort of wood, not allowing anything for waste, there were over four million cords cut somewhere, mostly in the United States; which means something like a million acres a year for pulp. Call it a half million for close measure. Do some figuring. If it costs twenty acres a Sunday, or forty acres a week, or 2,080 acres a year to print one daily newspaper, what does it cost in acreage to print all the newspapers in all the cities and towns of America? Add to this the enormous editions of our magazines. Add to this the paper used in books. The total

Slaughter of the forest. An old burn. Picture the frightful waste of good wood when a great forest region is reduced to this by repeated burnings. It has never been cut.

staggers the imagination, and yet the amount of timber cut for pulp in the United States annually is less than 5 per cent of what is cut for lumber.

It would seem that we can not afford much longer to read. Neither shall we long be able to write. Last year we made more than 315,000,000 lead pencils. A lead pencil is not very large, but the total number of lead pencils required 7,300,000 cubic feet of cedar. We have cedar enough to last us just twelve years.

More than 100,000 acres of timber in the whole United States are cut over every working day. We use many times more timber per capita than any other nation.

Slaughter of the forest. The trees are chopped down, peeled, and then the whole surface of the forest is burnt to the bone, so that the logs may be easily and cheaply dragged out.

We have left not over 450,000,000 acres bearing commercial timber. Cast up in your mind some of the small demands of industry noted above. Multiply this by three or four to represent the total, including all sorts of sawn lumber. Remember that you are dealing in terms of millions of acres. Divide 450,000,000 by your total number of millions of known demand. What is the result? Do you find it pleasant? Do you remain willing to listen to the charming of those who are either ignorant or hypocritical in their ''estimates?''

A WORLD PROBLEM.

Report of the Secretary of Agriculture for 1912.

It may fairly be said that half a generation ago the fear of a wood famine was a matter that had not entered the field of vision of the average man. Some sagacious ones, it is true, were giving practical but unostentatious evidence of their capacity to see ahead by gathering into their ownership all the cheap timberlands that they could acquire. Thus were laid the foundations of great fortunes. Timber reservations by no means began with the Government. The proceeds of lumbering in the virgin forests of the Northeast and in the matchless Lake State pineries, once Government owned, were often reinvested in southern yellow-pine lands or in the cream of western timber. This, however, was foresight exercised for private ends. Those who put their money into such investments counted—and with reason—on diminishing supplies to force up the value of their holdings. But those who urged the necessity of public action to provide for future public needs were thought to be disturbing themselves unduly in matters which were proper subjects for the attention of Providence rather than of men. To concern oneself overmuch lest wasteful use of the resources placed at human disposal might leave posterity with nothing to use argued a lack of confidence in the Divine wisdom which had put us in a world designed for the satisfaction of all essential needs. If the forests should ever fail, there would be something better to take their place.

This optimistic point of view was fostered by the very circumstances which in reality gave greatest cause for apprehension. Unexpected and momentous changes had revolutionized the conditions on which had been predicated the early forecasts of approaching need. While by falsifying these forecasts they had operated to lull the public mind into a feeling of unjustified security, they had actually created a situation a hundredfold more serious than before. In the eighteenth and early nineteenth centuries the question of forest supplies was purely local. Transportation except by water for any great distance was out of the question for so bulky a commodity.

Awakening to the Problem.

With the development of railroads affairs took on a wholly new aspect. Continental supplies were substituted for local. In the mid century the forests about the Great Lakes began to melt away, going east, west, and south, to rise again in the countless homes of an expanding nation. From open prairie to seaboard cities, from the factory towns and hamlets of New England to the growing commercial centers and the multiplying crossroad villages of the Middle West, they fed prosperity, and fireswept desolation blotted the land of their origin.

Thus was created a problem which is now not nation-wide, but world-wide. New York bids against South America and the Orient for the timber of the Pacific Northwest. Southern pine goes by water from the Gulf to Great Britain or the North Atlantic States; by rail, to meet the output of Montana's forests on the plains. In 1911 the United States exported domestic forest products to a total value of over $100,000,000, of which Europe took over $55,000,000 worth and South America about $25,000,000 worth. All the countries of eastern Europe must import timber to meet the excess of their needs over the home supply. Meanwhile, with an estimated home consumption of 23 billion cubic feet of wood annually, our depleted and abused forests are producing by growth probably less than 7 billion feet. The Bureau of Corporations of the Department of Commerce and Labor estimates the existing supply of saw timber in the United States at less than 3,000 billion board feet, which is equivalent to about 500 billion cubic feet. Economists now recognize that, taking the world over, wood consumption exceeds its growth, and that a crisis approaches.

* * *

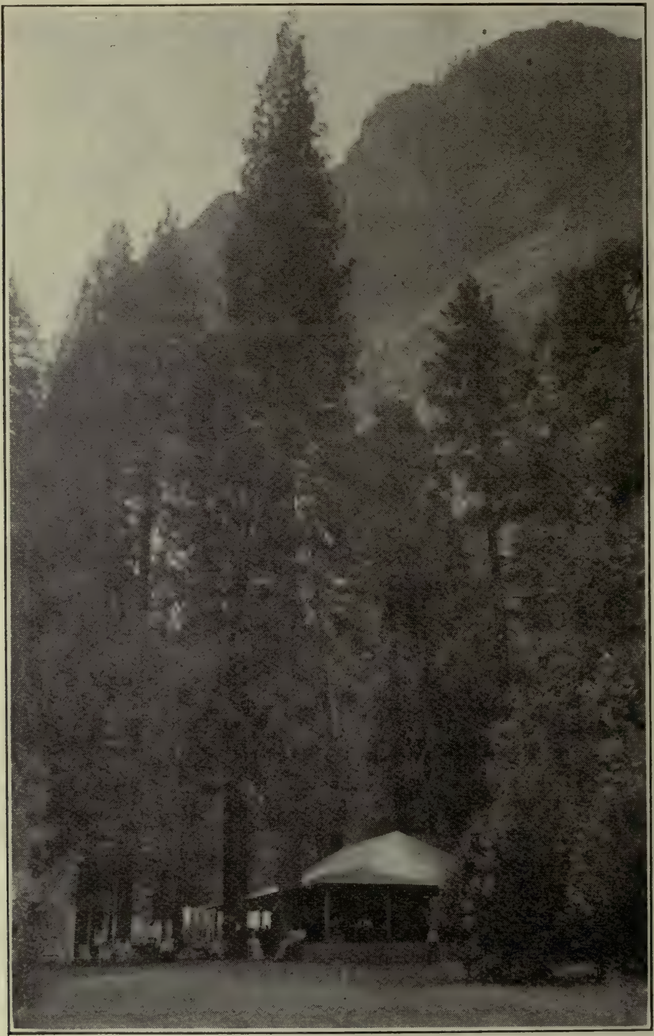
CALIFORNIA FORESTS.

By Coert DuBois, District Forester.

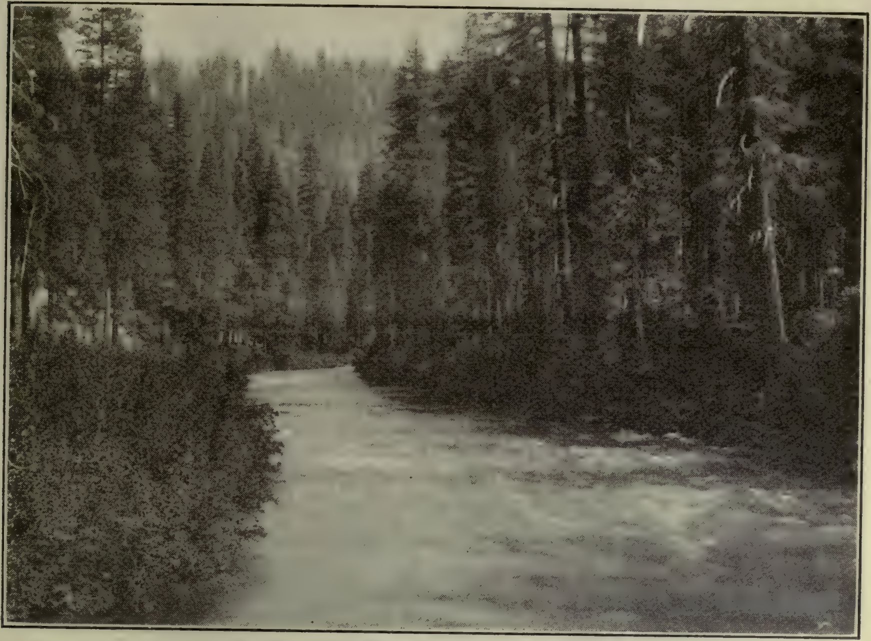
The State of California contains 101,310,080 acres of land. Of this, 27,000,000 acres lie in the nineteen National Forests controlled and administered by the United States Forest Service. This means that all the timber, the grazing lands, the water power, the minerals—all the natural resources which these forests contain—are held in trust by the Government for the benefit of the people, and sold or leased or given away under free use permit in accordance with a well defined, scientific, permanent policy.

There is something of the army spirit in the Forest Service—something of its coherence, its *esprit de corps;* but the significance underlying the two organizations is widely variant. The Army is a potential engine of destruction; the ideal of the Forest Service is a constructive one. Conservation—the intelligent use of natural resources—is the keynote of its policy.

It can be seen more clearly as a great business, in its methods and aims. Given a fund of capital such as the forests, the Forester and his men must apply themselves to the problem of so handling this capital that it will be of the greatest use to the present generation without diminishing or detracting from the heritage of generations to come. Let us look upon the work of the Service as a business—a business requiring sincerity of purpose and a deal of applied knowledge, both technical and of that rarer sort known as common sense. There is timber to be cut and sold; there are grazing privileges to be granted; mining claims and agricultural claims to be examined and give to *bona fide* claimants under the provisions of the mining laws and the Forest Homestead Act; there are waterpower sites to be leased; free use permits to be given; a multitude of special uses to be arranged, in short, all the details of any big business to be carried out.



A camp in Yosemite Forests. Surely we should preserve these recreation grounds unimpaired for the future.

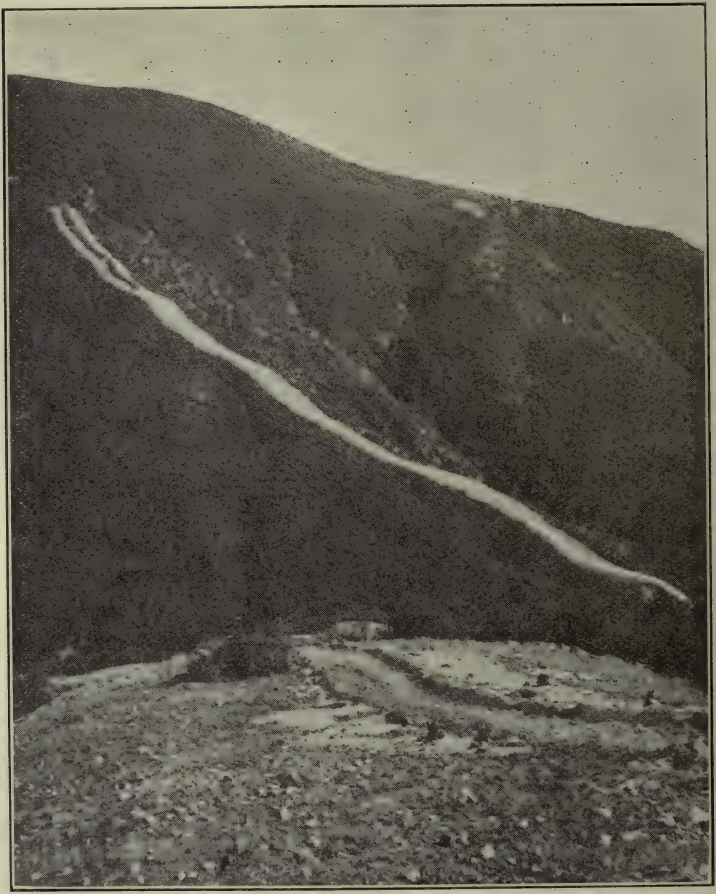


The shaggy forests of spruce and yellow pine come down to the edge of the water in northern California. This is McCloud River, a famous trout stream that drains the glaciers of Shasta.

The thin and scattered forests at the base of Grayback, in southern California are the life of the irrigation streams that nourish the orchards below. We destroy them at our peril.

And there is—in a class by itself—FIRE.

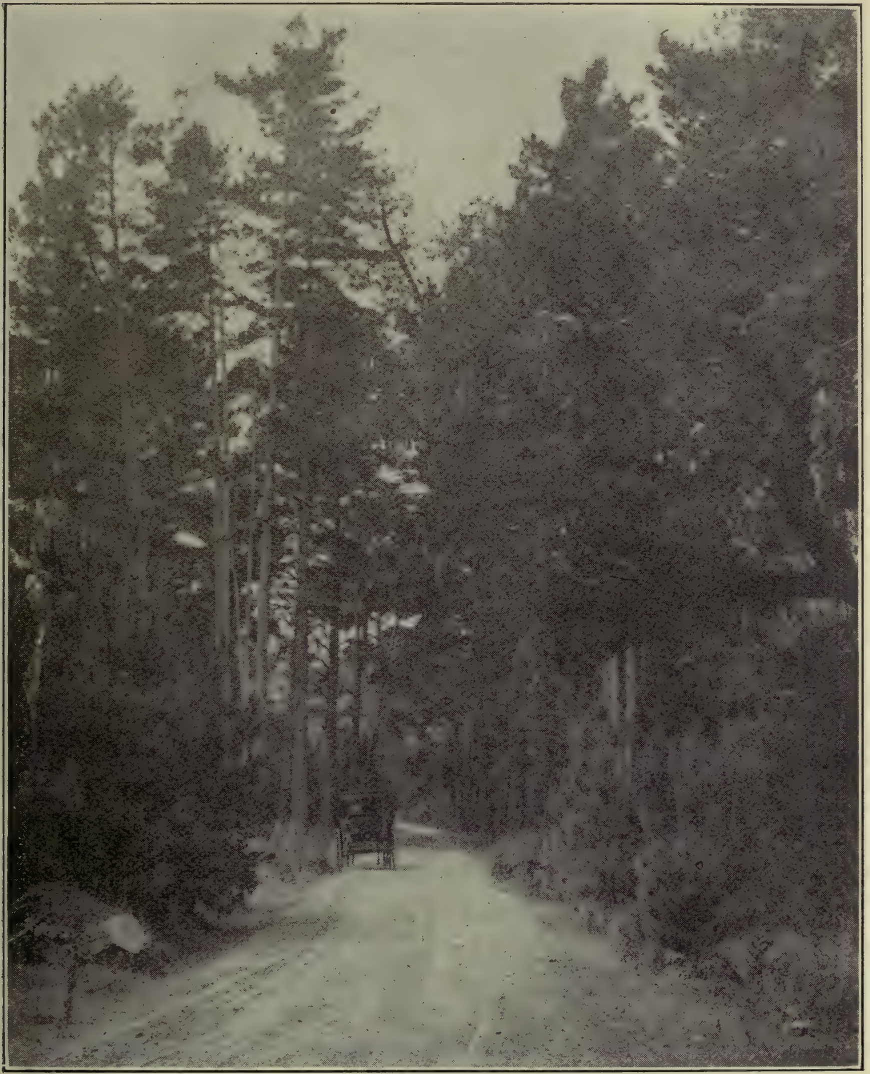
On the California National Forests the stand of live timber is estimated at 110 billion feet. It is worth approximately $250,000,000 as timber, to say nothing of its incalculable value to the Californians as a protection to the watersheds of the State. During four months of the year (on the average) these forests are menaced by fire. The biggest present problem of the Service is to protect the forests from this hazard. Two hundred and eighty thousand dollars, or about one half of the total appropriation for the California District of the United States Forest Service, is spent annually in maintaining the Service organization for fire defense. This is a great sum to pay for insurance, but it is necessary—and it is not disproportionate when one considers



A fire lane in the southern California mountains. A strip fifty feet wide is grubbed out through the tall brush straight across the foothills, to check the progress of fires. In the foreground a bit of the lane is seen at close range, with a trail in the middle.

the magnitude of the estate involved. The time is coming, however, when a fraction of this amount will suffice.

Hitherto, it has been necessary for us to attack the fire menace directly. Our organization for discovering fires when started, and suppressing them when discovered, is approaching completion. What we have to focus on now is a gradual reduction of the number of fires started, by getting at their causes.



Forests of the Monterey coast. Observe the change from the pine woods of the Sierras and the redwoods of the north.

Statistics kept for the past five years show that on the average 800 fires a year occur and 66 per cent of all are man-caused fires. Think of it! Through ignorance or carelessness or maliciousness, two thirds of all the forest fires in California are started by men. We have got to educate these men, and the general public as well, by every means in our power. We have got to drive home to them the effects of their carelessness. We have got to change their mental attitude from thoughtless irresponsibility or positive malice to an adequate appreciation of the values involved.

This is our big present problem. It has been said that ignorance is the great evil—that nothing, in truth, is really evil save ignorance. If a definite knowledge of the wonderful potential value of our California forests can be inculcated in the younger generation, if we can bring home to the boys and girls of our State the necessity for using every means in our power and in their power to save these forests for ourselves and for posterity, to keep fires out of them and to work in spreading this knowledge of the evil of fire, we will be by way of making the best use of the powerful engine of education.

THE CONVENTION OF GOVERNORS.

The first conference of the Governors of the United States and Territories was held at the White House, in Washington, D. C., during the three days beginning May 13, 1908.

The East Room was prepared for the occasion, its severe simplicity somewhat brightened by draperies of green velvet on the walls, about the platform on which were seated the presiding officer, the speakers, the Supreme Court, and the President's Cabinet. Two great maps, the largest ever made by mechanical means, hung on the east wall. One showed the timber resources of the United States, while the other showed the mineral deposits. Between these maps was an arrangement for illustrating the different phases of conservation by means of superb transparencies. On the floor special chairs were arranged in semi-circles for the Governors; while to the rear and at the sides were seats for the Governors' advisers and the guests.

Practically all the states and territories were represented; it was a historic occasion; nearly every speaker laid stress on the declaration that the meeting was an epoch-making one, that from it would spring an organization of the Governors that through its deliberations and the weight of its opinions would exercise through the years to come a tremendous influence over the destinies and the affairs of the nation.

Some extracts from the most notable of the many addresses delivered at this famous conference will be appropriate here as a fitting close to our handbook on Conservation.

SIGNIFICANCE OF THE MEETING.

The savage knows and confesses his dependence upon the forces of nature. His whole life is circumscribed by the resources of forest, field, and stream. Indeed, he feels himself a part of nature, and scarcely separates his fate from that of his surroundings. The game of the prairie, the forest, and the river, the berries and herbs in their season, and the living waters supply him with food and drink. With the changing seasons he moves from place to place, pursuing plenty. He winters in rude huts filled with smoke from fires of fallen wood, hardly less at the mercy of the cold than are the hibernating animals. In the spring he wakes with nature, and his summers are prosperous and happy only as the wild crop of field and forest are plentiful. He rises and lies down with the sun. He survives only as he observes nature and fits himself to her ways.

But as savagery gives place to civilization, man frees himself more and more from those bonds which bound him so closely to nature. Slowly and painfully at first, and then far more rapidly and easily, he learns to control his material surroundings. He breaks the prairie with the plow, makes the beasts of the field his servants, strikes the pick into the mountain and the axe into the veteran of the forest. He now no longer waits upon the seasons. He builds himself a house against the cold and warms himself to the point of comfort in the midst of the winter blast. Instead of passively accepting the wild fruits as they ripen he compels the soil to yield a harvest a millionfold more abundant, and this harvest he stores up against days of want. Instead of migrating with the birds he fixes his home where he will, and pursues his work and his pleasure in his own time.

Discovery and invention place new implements in his hands. With his intelligence quickened and his body trained by new experience and new occupations, he continues to increase his mastery over time, temperature, and place. New material riches become available. He is able to satisfy his wants more readily and more certainly than ever before. The standard of his living is raised. He now possesses and enjoys, besides all that his fathers required, a host of things of which they knew nothing. Wants multiply with prosperity, till his life becomes highly complex. He is lord of nature, because he has learned how to appropriate her resources.

But if the resources of nature should fail, where would be his mastery then?

This is the point which we commonly overlook. Man has laid nature under tribute, and has become powerful because nature was rich. Impoverish nature and her tribute stops. Ingenuity, capacity, labor, are incapable of extracting wealth from the gutted mine, from the fire-scorched brush land, from the sun-baked stream bed, from the impoverished soil. Civilization is achieved by the use of the resources of nature; it can endure no longer than the resources upon which it depends.

Living as we do to-day in the midst of conveniences which give us apparent independence of nature, it is almost inevitable that we should lose sight of this truth. It is difficult for us to realize that we, standing at the height of western civilization, are in fact vastly more dependent upon tributary nature than is the savage of the South Seas. Suppose the coal supply should give out in the middle of winter? Suppose a huge conflagration should sweep our forests from the hillsides? Suppose sudden floods should lay waste our fertile farm lands, scoring them with gullies or heaping them with sand? Would not any single one of these calamities bring upon us incalculable losses and suffering?

And yet these suppositions are not imaginary. We need to look only a very little way ahead, as things are going now, in order to see them realized, in effect. True, the failure of our resources will not come suddenly, and such of our resources as can be renewed need never fail if we use them wisely. But the exhaustible resources, chief among which are the mines, are coming to an end as certainly as if the end were to-day, while those resources whose exhaustion is due not to necessity, but to folly, have no future unless we insure it by our own provision.

It is clear, therefore, that the question how we shall make the best use of our natural resources, renewable and not renewable, is a pressing question of the hour. Where renewal is impossible, there is need of the strictest economy; and where renewal can be secured by prudence and foresight, the very existence of the nation demands that prudence and foresight be exercised.

This is the significance of the Conference of Governors on the Conservation of Natural Resources held at the White House, May 13-15, 1908, which took up for the first time the problem of conservation in all its details.

TREADWELL CLEVELAND, JR.

A NEW PATRIOTIC IMPULSE.

The World's Work Magazine summed up the Governors' Conference in its editorial correspondence as follows.

It was the most notable company of men that has come together in our country in recent times. The official head of the nation, the Cabinet, the Supreme Court, certain members of Congress, the heads of the states, and, besides these, many of the most distinguished scientific men that we have and men of a sound grasp of public subjects who came as "advisers" to the Governors—two or three of the most noteworthy citizens of every state—among them the presidents of many of our foremost universities and schools of science; and, besides these, representatives of all the most important national organizations of scientific and commercial bodies.

About the general proposition that this extraordinary meeting was called to emphasize there was no difference of opinion. And the wealth of facts that were presented put the subject in every mind in a new way, and aroused every man to an argent purpose. When one subject was put into every mind as the foremost subject of public action that this generation can have, and was so presented and emphasized as to win universal assent and to arouse a patriotic purpose, then all the machinery of publicity, of exhortation, and of public action that a democracy can have was put in action at one stroke.

The scientific papers presented to the Conference, giving exact data about agriculture, streams, forests, coal, and all similar subjects, were the most practical and helpful literature of waste and of methods of conservation ever put together. They will become a classic description of our great resources as they now are.

The brief speeches by many of the Governors were in the nature of an ''experience meeting.'' They told of the work that the state governments are doing to save and to reclaim. And the resolutions adopted called on the government, local and national, and on the people to preserve our national wealth.

Every man came away from the most noteworthy gathering that he ever attended, with a new love of his country, a new attitude toward it, a new conscience about the land, the trees, and the streams; and we entered then on a new era in our national thought and in our attitude toward our land.

ANDREW CARNEGIE.

The ironmaster of Pittsburg, who has scattered libraries over this continent like the sands of the sea, delivered a striking address from which only a few extracts can be given.

In view of the sobering facts presented, the thoughtful man is forced to realize, first, that our production and consumption of minerals are increasing much more rapidly than our population; and, second, that our methods are so faulty and extravagant that the average waste is very great, and in coal almost as great as the amount consumed. The serious loss of life in the mines is a feature that can no longer be overlooked. Nor can we fail to realize that the most useful minerals will shortly become scarce, and may soon reach prohibitive cost unless steps to lessen waste are taken in the interest of the future.

I have for many years been impressed with the steady depletion of our iron ore supply. It is staggering to learn that our once supposed ample supply of rich ores can hardly outlast the generation now appearing, leaving only the leaner ores for the later years of the century. It is my judgment, as a practical man accustomed to dealing with those material factors on which our national prosperity is based, that it is time to take thought for the morrow.

We are nationally in the position of a large family receiving a rich patrimony from thrifty parents deceased intestate; the President may be likened to the eldest son, and the Governors to younger brothers, jointly responsible for the minors; the experts assembled may be likened to the family solicitors. Now, the first duty of such a family is to take stock of its patrimony; the next to manage the assets in such manner that none shall be wasted, that all be put to the greatest good of the living and their descendants. Now, we have just begun to take stock of our national patrimony; and it is with the deepest sense of responsibility imposed upon me by the invitation to this meeting, to the nation, and to coming generations of all time, that I speak as one of the junior solicitors. In my opinion, we should watch closely all the assets and begin both to save and to use them more wisely.

Let us begin with iron: We must in all possible ways lessen the demands upon it, for it is with iron ore we are least adequately provided. One of the chief uses of this metal is connected with transportation, mainly by rail. Moving 1,000 tons of heavy freight by rail requires an 80-ton locomotive and twenty-five 20-ton steel cars (each of 40-ton capacity), or 580 tons of iron and steel, with an average of, say, ten miles of double track (with 90-pound rails), or 317 tons additional; so that, including switches, frogs, fish-plates, spikes, and other incidentals, the carrier requires the use of an equal weight of metal. The same freight may be moved by water by means of 100 to 250 tons of metal, so that the substitution of water-carriage for rail-carriage would reduce the consumption of iron by three fourths to seven eighths in this department. At the same time the consumption of coal for motive power would be reduced 50 to 75 per cent, with a corresponding reduction in the coal required for smelting. No single step open to us to-day would do more to check the drain on iron and coal than the substitution of water-carriage for rail-carriage wherever practicable, and the careful adjustment of the one to the other throughout the country.

NATURAL GAS.

Dr. White, the State Geologist of West Virginia, presented in vivid fashion a picture of the waste of our purest form of fuel. This is of interest to us in California, because we, too, have great fields of petroleum and natural gas being used in similar ways. In Fresno and Kern counties are many thousands of acres of open oil reservoirs from which the most valuable parts of the oil are evaporating by night and by day. Gushers throw up to the sky vast columns of oil and gas, drenching the country for miles around with the precious fuel, and wasting it into the upper air. Every feature in the West Virginia account below is repeated and repeated in our own State. The loot of California's oil fields is said to have made more than two hundred sudden millionaires. Are they worth what they have cost?

A great geologist once said, "The nations that have coal and iron will rule the world." Bountiful nature has dowered the American people with a heritage of both coal and iron richer by far than that of any other political division of the earth.

It was formerly supposed that China would prove the great storehouse from which the other nations could draw their supplies of carbon when their own had become exhausted, but the recent studies of a brilliant American geologist in that far-off land, rendered possible by the generosity of the world's greatest philanthropist, tell a different story. The fuel resources of China, great as they undoubtedly are, have been largely overestimated, and Mr. Willis reports that they will practically all be required by China herself, and that the other nations can not look to her for this all-important element in modern industrial life.

A simple glance at a geological map of the United States will convince any one that nature has been most lavish to us in fuel resources, for we find a series of great coal deposits extending in well scattered fields almost from the Atlantic to the Pacific, from the Lakes to the Gulf, while even over much of New England and the coastal plains, vast areas of peat, the primal stage of coal, have been distributed. But coal of every variety from peat to anthracite is not all of nature's fuel gifts to fortunate America. Great deposits of both petroleum and natural gas occur in nearly every state where coal exists, and in some that have no coal. What greater dowry of fuels could we ask when we find them stored for us within the bosom of our mother earth in all three of the great types—coal, petroleum, and natural gas—only awaiting the tap of the pick and drill to bring them forth in prodigal abundance?

What account can we as a nation give of our stewardship of such vast fuel treasures? Have we carefully conserved them, using only what was necessary in our domestic and industrial life, and transmitting the remainder, like prudent husbandmen, unimpaired to succeeding generations? Or have we greatly depleted this priceless heritage of power and comfort, and source of world-wide influence, by criminal waste and wanton destruction? The answer should bring a blush of shame to every patriotic American, for not content with destroying our magnificent forests, the only fuel and supply of carbon known to our forefathers, we are with ruthless hands and regardless of the future applying both torch and dynamite to the vastly greater resources of this precious carbon which provident nature has stored for our use in the buried forests of the distant past. The wildest anarchists, determined to destroy and overturn the foundations of government, could not act in a more irrational and thoughtless manner than have our people in permitting such fearful destruction of the very sources of our power and greatness. Let me enumerate some of the details of this awful waste of our fuel resources that has been going on with ever-increasing speed for the last forty years.

First, let us consider how we have wasted natural gas, the purest form of fuel, ideal in every respect, self-transporting, only awaiting the turning of a key to deliver to our homes and factories heat and light and power. Partial nature has apparently denied this great boon to many other lands. It is practically unknown in France, Germany, and Great Britain, our chief competitors in the world of industry. Even wood and coal must first be converted into gas before they will burn, but here is a fuel of which nature has given us a practical monopoly, lavish in abundance, already transmuted into the gaseous stage and stored under vast pressure to be released wherever wanted at our bidding. The record of waste of this our best and purest fuel is a national disgrace.

At this very minute this unrivaled fuel is passing into the air within our domain from uncontrolled gas wells, from oil wells, from giant flambeaus, from leaking pipe lines and the many other methods of waste at the rate of not less than one billion cubic feet daily and probably much more.

Very few appear to realize either the great importance of this hydrocarbon fuel resource of our country, or its vast original quantity. Some of the individual wells, if we may credit the measurements, have produced this fuel at the rate of 70,000,000 cubic feet daily, the equivalent in heating value of 70,000 bushels of coal, or nearly 12,000 barrels of oil. In my humble opinion the original amount of this volatile fuel in the United States, permeating, as it does, every undisturbed geologic formation from the oldest to the most recent, rivaled or even exceeded in heating value, all of our wondrous stores of coal.

Suppose that it were possible for some Nero, inspired by a mania of incendiarism, to apply a consuming torch to every bed of coal that crops to the surface from the Atlantic to the Pacific, and that the entire coal supply of the Union was threatened with destruction within a very few years, what do you think would happen? Would our state legislatures sit undisturbed panoplied by such a carnival of fire? Would the governors of thirty states remain silent while the demon of flame was ravaging the coal resources of the republic? Certainly not; there would be a united effort by the governors and legislatures of all the states in the Union to stay the progress of such a direful conflagration; even the sacred constitutional barriers wisely erected between state and federal authority would melt away in the presence of such an awful calamity, and the mighty arm of the nation would be invoked to help end the common peril to every interest. And yet this imaginary case is an *actual one* with the best and purest fuel of the country, equal probably in quantity and value for heat, light, and power to all of our coal resources. This blazing zone of destruction extends in a broad band from the Lakes to the Gulf, and westward to the Pacific, embracing in its flaming pathway the most precious fuel possessions of a continent. No one can even approximate the extent of this waste. From personal knowledge of conditions which exist in every oil and gas field, I am sure the quantity will amount to not less than one billion cubic feet daily, and it may be much more. The heating value of a billion cubic feet of natural gas is roughly equivalent to that of one million bushels of coal. What an appalling record to transmit to posterity!

From one well in eastern Kentucky there poured a stream of gas for a period of twenty years without any attempt to shut it in or utilize it, the output of which, it has been figured, was worth at current prices more than three million dollars. Practically the same conditions characterized the first twenty-five years of Pennsylvania's oil and gas history, and the quantity of wasted gas from thousands of oil and gas wells in western Pennsylvania is beyond computation. In my own state of West Virginia, only eight years ago, not less than 500,000,000 cubic feet of this precious gas was daily escaping into the air from two counties alone, practically all of which was easily preventable, by a moderate expenditure for additional casing. When it is remembered that one thousand cubic feet of natural gas weighs 48 pounds, and that 6,000 cubic feet of it would yield a 42-gallon barrel of oil when condensed, so that a well flowing 6,000,000 feet of gas is pouring into the air daily the equivalent of 1,000 barrels of oil, what would our petroleum kings think, if they could see this river of oil (for the equivalent of a billion feet of gas is more than 160,000 barrels of petroleum, and of practically the same chemical composition as benzine or gasoline) rushing unhindered to the sea? Would they not spend millions to check such a frightful waste of this golden fluid? And would they not be the first to appeal to the national government for aid in ending such great destruction of property? And yet because natural gas is invisible, and its waste is not so apparent to the eye as a stream of oil, or a burning coal mine, the agents of these oil magnates have not only permitted this destruction of the nation's fuel resources to continue, but they have prevented by every means in their power the enactment of any legislation to stop this frightful loss of the best and purest fuel that nature has given to man.

There can be no doubt that for every barrel of oil taken from the earth there have been wasted more than ten times its equivalent in either heating power, or weight even, of this the best of all the fuels, and also that much more than half of this frightful waste could have been avoided by proper care in oil production and slight additional expenditures.

In justice to the great oil-producing corporations, it must be acknowledged that they have not permitted much waste of petroleum except what has been sprayed into the air by their awful waste of gas, and also that their handling of petroleum has been from the beginning a model of business economy and management. The great mistake of the oil-producing interests has been in not properly apprehending the enormous fuel value of the natural gas they were destroying, and in not demanding legislation for its protection instead of successfully throttling and preventing it in every state of the Union except one—Indiana. When the people of that great state awoke to the fact that their richest mineral possession was being rapidly wasted, they rose to the occasion, and although it was largely a case of ''locking the stable door after the horse had been stolen,'' they effectually prevented any further useless waste of natural gas. This Indiana statute which has been declared constitutional by our highest courts, says in effect to the oil producers: ''You can not take the oil from the ground where nature has safely stored it, until you provide a method of utilizing the accompanying gas, or volatile oil as well,'' and it also says to both the producer and consumer of natural gas, that it is against ''public policy to waste this valuable fuel, and that it will not be permitted to either party.'' This Indiana statute for the conservation of petroleum and natural gas should be enacted into law in every state where this precious fuel exists; and why has it not been done?

JAMES J. HILL.

The railroad magnate of the Great Northern is recognized not only as a captain of industry, but as a high authority on the lands and resources of the United States. His thoughts are well worth weighing.

''Of all the sinful wasters of man's inheritance on earth,'' said the late Professor Shaler, ''and all are in this regard sinners, the very worst are the people of America.'' This is not a popular phrase, but a scientific judgment. It is borne out by facts. In the movement of modern times, which has made the world commercially a small place, and has produced a solidarity of the races such as never before existed, we have come to the point where we must to a certain extent regard the natural resources of this planet as a common asset, compare them with demands now made and likely to be made upon them, and study their judicious use. Commerce, wherever untrammeled, is wiping out boundaries and substituting the world relation of demand and supply for smaller systems of local economy. The changes of a single generation have brought the nations of the earth closer together than were the states of this Union at the close of the Civil War. If we fail to consider what we possess of wealth available for the uses of mankind, and to what extent we are wasting a national patrimony that can never be restored, we might be likened to the directors of a company who never examine a balance sheet.

The sum of resources is simple and fixed. From the sea, the mine, the forest and the soil must be gathered everything that can sustain the life of man. Upon the wealth that these supply must be conditioned forever, as far as we can see, not only his progress, but his continued existence on earth. How stands the inventory of property for our own people? The resources of the sea furnish less than five per cent of the food supply, and that is all. The forests of this country, the product of centuries of growth, are fast disappearing. The best estimates reckon our standing merchantable timber at less than 2,000,000,000,000 feet. Our annual cut is about 40,000,000,000,000 feet. The lumber cut rose from 18,000,000,000 feet in 1880 to 34,000,000,000 feet in 1905; that is, it nearly doubled in twenty-five years. We are now using annually 500 feet board measure of timber per capita, as against an average of 60 for all Europe. The New England supply is gone. The Northwest furnishes small growths that would have been rejected by the lumbermen of thirty years ago. The South has reached its maximum production and begins to decline. On the Pacific coast only is there now any considerable body of merchantable standing timber. We are consuming yearly three or four times as much timber as forest growth restores. Our supply of some varieties will be practically exhausted in ten or twelve years; in the case of others, without reforesting, the present century will see the end. When will we take up in a practical and intelligent way the reforestation of our forests? * * *

The exhaustion of our coal supply is not in the indefinite future. The startling feature of our coal production is not so much the magnitude of the annual output as its rate of growth. For the decade ending in 1905 the total product was 2,832,402,746 tons, which is almost exactly one half the total product previously mined in this country. For the year 1906 the output was 414,000,000 tons, an increase of 46 per cent on the average annual yield of the ten years preceding. In 1907 our production reached 470,000,000 tons. Fifty years ago the annual per capita production was a little more than one quarter of a ton. It is now about five tons. It is but eight years since we took the place of Great Britain as the leading coal-producing nation of the world, and already our product exceeds hers by over 43 per cent, and is 37 per cent of the known production of the world. Estimates of coal deposits still remaining must necessarily be somewhat vague, but they are approximately near the mark. The best authorities do not rate them at much over 2,000,000,000,000 tons. If coal production continues to increase as it has in the last ninety years, the available supply will be greatly reduced by the close of the century. Before that time arrives, however, resort to lower grades and sinking of mines to greater depths will become necessary, making the product inferior in quality and higher in price. Already Great Britain's industries have felt the check from a similar cause, as shown in her higher cost of production. Our turn will begin probably within a generation or two from this time. Yet we still think nothing of consuming this priceless resource with the greatest possible speed. Our methods of mining are often wasteful; and we not only prohibit our industries from having recourse to the coal supplies of other countries, but actually pride ourselves upon becoming exporters of a prime necessity of life and an essential of civilization.

The iron industry tells a similar story. The total of iron ore mined in the United States doubles about once in seven years. It was less than 12,000,000 tons in 1893, over 24,000,000 tons in 1899, 47,740,000 tons in 1906, and over 52,000,000 tons in 1907. The rising place of iron in the world's life is the most impressive phenomenon of the last century. In 1850 the pig iron production of the United States amounted to 563,757 tons, or about 50 pounds per capita. Our production now is over 600 pounds per capita. We do not work a mine, build a house, weave a fabric, prepare a meal or cultivate an acre of ground under modern methods without the aid of iron. We turn out over 25,000,000 tons of pig iron every year, and the production for the first half of 1907 was at the rate of 27,000,000 tons. This is two and one half times the product of Great Britain. It is nearly half the product of the whole world. And the supply of this most precious of all the metals is so far from inexhaustible that it seems as if iron and coal might be united in their disappearance from common life.

We now turn to the only remaining resource of man upon this earth, which is the soil itself. How are we caring for that, and what possibilities does it hold out to the people of future support? We are only beginning to feel the pressure upon the land. The whole interior of this continent, aggregating more than 500,000,000 acres, has been occupied by settlers within the last fifty years. What is there left for the next fifty years? Excluding arid and irrigable areas, the latter limited by nature, and barely enough of which could be made habitable in each year to furnish a farm for each immigrant family, the case stands as follows: In 1906 the total unappropriated public lands in the United States consisted of 792,000,000 acres. Of this area the divisions of Alaska, Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, and Wyoming contained 195,700,000 acres of unsurveyed land. Little of Alaska is fitted for general agriculture, while practically all of the rest is semi-arid, available only for grazing or irrigation. We have (subtracting these totals) 50,000,000 acres of surveyed and 36,500,000 acres of unsurveyed land as our actual remaining stock. And 21,000,000 acres were disposed of in 1907. How long will the remainder last? No longer can we say that "Uncle Sam has enough to give us all a farm."

Equally threatening is the change in quality. There are two ways in which the productive power of the earth is lessened: first by erosion and the sweeping away of the fertile surface into streams and thence to the sea; and, second, by exhaustion through wrong methods of cultivation. The former process has gone far. Thousands of acres in the East and South have been made unfit for tillage. North Carolina was, a century ago, one of the great agricultural states of the country, and one of the wealthiest. To-day as you ride through the South you see everywhere land gullied by torrential rains, red and yellow clay banks exposed where once were fertile fields; and agriculture reduced because its main support has been washed away. Millions of acres, in places to the extent of one tenth of the entire arable area, have been so injured that no industry and no care can restore them.

Far more ruinous, because universal and continuing in its effects, is the process of soil exhaustion. It is creeping over the land from East to West. The abandoned farms that are now the playthings of the city's rich or the game preserves of patrons of sport, bear witness to the melancholy change. New Hampshire, Vermont, northern New York, show long lists of them. In Western Massachusetts, which once supported a flourishing agriculture, farm properties are now for sale for half the cost of the improvements. Professor Carver, of Harvard, has declared, after a personal examination of the country, that ''agriculture as an independent industry, able in itself to support a community, does not exist in the hilly parts of New England.''

The same process of deterioration is affecting the farm lands of western New York, Ohio, and Indiana. Where prices of farms should rise by increase of population, in many places they are falling. Between 1880 and 1900 the land values of Ohio shrank $60,000,000. Official investigation of two counties in central New York disclosed a condition of agricultural decay. In one land was for sale for about the cost of improvements, and 150 vacant houses were counted in a limited area. In the other the population in 1905 was nearly 4,000 less than in 1855.

Practically identical soil conditions exist in Maryland and Virginia, where lands sell at from $10 to $30 an acre. In a hearing before an industrial commission, the chief of the Bureau of Soils of the Department of Agriculture said: ''One of the most important causes of deterioration, and I think I should put this first of all, is the method and system of agriculture that prevails throughout these states. Unquestionably the soil has been abused.'' The richest region of the West is no more exempt than New England or the South. The soil of the West is being reduced in agricultural potency by exactly the same processes which have driven the farmer of the East, with all his advantage of nearness to markets, from the field.

Within the last forty years a great part of the richest land in the country has been brought under cultivation. We should, therefore, in the same time, have raised proportionately the yield of our principal crops per acre; because the yield of old lands, if properly treated, tends to increase rather than diminish. The year 1906 was one of large crops, and can scarcely be taken as a standard. We produced, for example, more corn that year than had ever been grown in the United States in a single year before. But the average yield per acre was less than it was in 1872. We are barely keeping the acre product stationary. The average wheat crop of the country now ranges from twelve and one half, in ordinary years, to fifteen bushels per acre in the best seasons. And so it is on down the line.

Not only the economic but the political future is involved. No people ever felt the want of work or the pinch of poverty for a long time without reaching out violent hands against their political institutions, believing that they might find in a change some relief from their distress. Although there have been moments of such restlessness in our country, the trial has never been so severe or so prolonged as to put us to the test. It is interesting that one of the ablest men in England during the last century, a historian of high merit, a statesman who saw active service and a profound student of men and things, put on record his prophecy of such a future ordeal. Writing to an American correspondent fifty years ago, Lord Macaulay used these words: "As long as you have a boundless extent of fertile and unoccupied land, your laboring population will be found more at ease than the laboring population of the Old World; but the time will come when wages will be as low and will fluctuate as much with you as they do with us. Then your institutions will be brought to the test. Distress everywhere makes the laborer mutinous and discontented, and inclines him to listen with eagerness to agitators who tell him that it is a monstrous iniquity that one man should have a million and another can not get a full meal. * * * The day will come when the multitudes of people, none of whom has had more than half a breakfast or expects to have more than half a dinner, will choose a legislature. Is it possible to doubt what sort of legislature will be chosen? * * * There will be, I fear, spoliation. The spoliation will increase the distress; the distress will produce a fresh spoliation. * * * Either civilization or liberty will perish. Either some Cæsar or Napoleon will seize the reins of government with a strong hand, or your republic will be as fearfully plundered and laid waste by barbarians in the twentieth century as the Roman Empire in the fifth." We need not accept this gloomy picture too literally, but we have been already sufficiently warned to prevent us from dismissing the subject as unworthy of attention. Every nation finds its hour of peril when there is no longer free access to the land, or when the land will no longer support the people. * * * Far may this day be from us. But since the unnecessary destruction of our land will bring new conditions of danger, its conservation, its improvement to the highest point of productivity promised by scientific intelligence and practical experiment, appears to be a first command of any political economy worthy of the name.

If this patriotic gospel is to make headway, it must be by just such organized missionary work as is to-day begun. It can not go on and conquer if imposed from without. It must come to represent the fixed idea of the people's mind, their determination and their hope. It can not be incorporated in our practical life by the dictum of any individual or any officer of nation or state in his official capacity. It needs the co-operation of all the influences, the help of every voice, the commendation of nation and state that has been the strength and inspiration of every worthy work on American soil for one hundred and twenty years. We return, for our gathering in council and for our plan of action for the future, to the model given us by the fathers. State and Nation are represented here, without jealousy or any ambition of superiority on either side, to apply to the consideration of our future such co-operation as that out of which this nation was born, and by which it has won to worthly manhood. Reviving the spirit of the days that created our Constitution, the days that carried us through civil conflict, the spirit by which all our enduring work in the world has been wrought, taking thought as Washington and Lincoln took thought, only for the highest good of all the people, we may, as a result of the deliberations held and the conclusions reached here to-day, give new meaning to our future; new lustre to the ideal of a republic of living federated states; shape anew the fortunes of this country, and enlarge the borders of hope for all mankind.

THE SECRETARY OF AGRICULTURE.

Perhaps no one has had a better opportunity to know about the soil of this nation than James Wilson, the Secretary of Agriculture. He made the following remarks:

''The paper read by Mr. Hill this morning made a very deep impression upon me. The greatest asset we have in the United States is our soil; we are destroying that as rapidly as we can, and the oldest settled part of the United States has made the most progress in the destruction of our soil. Down on the Gulf coast the land has been peopled longer than the upper part of the Mississippi Valley. The heavy rainfalls, and the perpetual cultivation and growing of crops have helped erosion, and the soil has been destroyed in that way. It is going off very, very rapidly. The cure is a system of agriculture that will keep the soil filled with plant food, organic matter, humus. That is the cure; that is the way to keep up the soil. Somebody once asked an English gardener how he got such a fine lawn. He had a beautiful grass lawn which attracted attention. He said, 'We weeded, and we weeded; we manured and we manured, for eight hundred years'; and that is the way they got it.''

IN WISCONSIN.

The Governor of Wisconsin graphically described the recent history of his own state.

"Great lumber companies," said Governor Davidson, "inspired only by an enthusiasm and a greed which knew no bounds, attacked our forests, engaging in a mad race each to strip its territory, to market its lumber first, and then to move forward and continue the destruction. No tree was regarded as too small to escape cutting. Trunks six inches in diameter were cut for lumber. Millions of young trees and saplings, which were too small to have any commercial value, were crushed by falling timber, or were cut to make room for logging roads. Those that escaped the axe of the loggers fell victims to forest fires, the destruction by which can only be counted by the millions of dollars—a further melancholy evidence of the carelessness with which our forest tracts were guarded.

"To-day we are beginning to feel the penalty for this indifference. Our proud position as the greatest timber state of the Union has passed to others. Thousands of acres of land of no value for agriculture have been rendered bare and practically worthless; our swamps are drying up, and as a consequence many of our streams have shrunk to but a small proportion of their former size. The destruction of our forests has taken from us that great regulator of the streams, for with no forests to protect the head water of rivers and to detain the water upon the soil, we have frequent freshets and floods, and are confronted with the problem of dealing with rapidly rising and falling stream volume—a condition which has already rendered many of our one-time valuable water powers practically worthless."

A DISSENTING VIEW.

President James of the University of Illinois dissented from the ideas of the other speakers.

It was his optimistic opinion, that no such waste as had been alluded to by previous speakers had existed in this country; or, if it did exist, it was not really waste, but the simple methods that, instinctively adopted by the early settlers of the country, had proven themselves in the main correct. He said that the fact that farms of the East have passed out of cultivation is not necessarily an indication that those farms have lost their productive power, but, rather, that they have been abandoned because of the opening up of broader fields of usefulness in the regions beyond the Mississippi and the Missouri, and he said he believed that, after all is said and done, the greatest natural resources the country possesses is not in its forests, its rivers, its mines, or its soil, but in the brains of it people.

DECLARATION OF PRINCIPLES.

Before adjourning, the Governors signed the following Declaration as embodying the results of the Convention:

DECLARATION.

We, the Governors of the States and Territories of the United States of America, in conference assembled, do hereby declare the conviction that the great prosperity of our country rests upon the abundant resources of the land chosen by our forefathers for their homes, and where they laid the foundation of this great nation.

We look upon these resources as a heritage to be made use of in establishing and promoting the comfort, prosperity, and happiness of the American people, but not to be wasted, deteriorated, or needlessly destroyed.

We agree that our country's future is involved in this: that the great natural resources supply the material basis upon which our civilization must continue to depend, and upon which the perpetuity of the nation itself rests.

We agree, in the light of the facts brought to our knowledge and from information received from sources which we can not doubt, that this material basis is threatened with exhaustion. Even as each succeeding generation from the birth of the nation has performed its part in promoting the progress and development of the Republic, so do we in this generation recognize it as a high duty to perform our part; and this duty in large degree lies in the adoption of measures for the conservation of the natural wealth of the country.

We declare our firm conviction that this conservation of our natural resources is a subject of transcendent importance, which should engage unremittingly the attention of the nation, the States, and the people in earnest co-operation. These natural resources include the land on which we live and which yields our food; the living waters which fertilize the soil, supply power, and form great avenues of commerce; the forests which yield the materials for our homes, prevent erosion of the soil, and conserve the navigation and other uses of the streams; and the minerals which form the basis of our industrial life, and supply us with heat, light, and power.

We agree that the land should be so used that erosion and soil wash shall cease; and that there should be reclamation of arid and semi-arid regions by means of irrigation, and of swamp and overflowed regions by means of drainage; that the waters should be so conserved and used as to promote navigation, to enable the arid regions to be reclaimed by irrigation, and to develop power in the interests of the people; that the forests which regulate our rivers, support our industries, and promote the fertility and productiveness of the soil should be preserved and perpetuated; that the minerals found so abundantly beneath the surface should be so used as to prolong their utility; that the beauty, healthfulness, and habitability of our country should be preserved and increased; that sources of national wealth exist for the benefit of the people, and that monopoly thereof should not be tolerated.

We commend the wise forethought of the President in sounding the note of warning as to the waste and exhaustion of the natural resources of the country, and signify our high appreciation of his action in calling this conference to consider the same and to seek remedies therefor through co-operation of the Nation and States.

We agree that this co-operation should find expression in suitable action by the Congress within the limits of and coextensive with the national jurisdiction of the subject, and, complimentary thereto, by the Legislatures of the several States within the limits of and coextensive with their jurisdiction.

We declare the conviction that in the use of the national resources our independent States are interdependent and bound together by ties of mutual benefits, responsibilities, and duties.

We agree in the wisdom of future conferences between the President, Members of Congress, and the Governors of States on the conservation of our natural resources with a view of continued co-operation and action on the lines suggested; and to this end we advise that from time to time, as in his judgment may seem wise, the President call the Governors of States and Members of Congress and others into conference.

We agree that further action is advisable to ascertain the present condition of our natural resources and to promote the conservation of the same; and to that end we recommend the appointment by each State of a commission on the conservation of natural resources, to co-operate with each other and with any similar commission of the Federal Government.

We urge the continuation and extension of forest policies adapted to secure the husbanding and renewal of our diminishing timber supply, the prevention of soil erosion, the protection of head waters, and the maintenance of the purity and navigability of our streams. We recognize that the private ownership of forest lands entails responsibilities in the interests of the people, and we favor the enactment of laws looking to the protection and replacement of privately owned forests.

We recognize in our waters a most valuable asset of the people of the United States, and we recommend the enactment of laws looking to the conservation of water resources for irrigation, water supply, power, and navigation, to the end that navigable and source streams may be brought under complete control and fully utilized for every purpose. We especially urge on the Federal Congress the immediate adoption of a wise, active, and thorough waterway policy, providing for the prompt improvement of our streams and the conservation of their watersheds required for the uses of commerce and the protection of the interests of our people.

We recommend the enactment of laws looking to the prevention of waste in the mining and extraction of coal, oil, gas, and other minerals with a view to their wise conservation for the use of the people, and to the protection of human life in the mines.

Let us conserve the foundations of our prosperity.

FINAL WORD.

This handbook should be duly stamped, catalogued and placed in the school library for future reference. It will be needed for essays and compositions, debates and recitations, readings and memory gems. It will surely be wanted for reference. After this edition is exhausted it will not be possible to get duplicates. The edition of 1909 disappeared in a year and many thousands of demands were refused, from people of this State and other states as well. Even to this day requests are coming in for it. Its value grows largely as it becomes scarce. It will never be reprinted. Therefore, preserve your copy against a future need for this kind of material.

Senate #460 (companion)

ASSEMBLY BILL No. 605

INTRODUCED BY MR. FISH,

JANUARY 22, 1915.

REFERRED TO COMMITTEE ON CONSERVATION.

AN ACT

PROVIDING FOR THE PROTECTION OF PUBLIC AND PRIVATE FOREST LANDS BY REGULATION AND PREVENTION OF FIRES; CREATING THE OFFICE OF STATE FORESTER, AND FIXING HIS POWERS AND DUTIES; PRESCRIBING PENALTIES FOR VIOLATIONS OF THE PROVISIONS HEREOF; REPEALING AN ACT ENTITLED "AN ACT TO PROVIDE FOR THE REGULATION OF FIRES ON, AND THE PROTECTION AND MANAGEMENT OF, PUBLIC AND PRIVATE FOREST LANDS WITHIN THE STATE OF CALIFORNIA, CREATING A STATE BOARD OF FORESTRY AND CERTAIN OFFICERS SUBORDINATE TO SAID BOARD, PRESCRIBING THE DUTIES OF SUCH OFFICERS, CREATING A FORESTRY FUND, AND APPROPRIATING THE MONEYS IN SAID FUND, AND DEFINING AND PROVIDING FOR THE PUNISHMENT OF CERTAIN OFFENSES FOR VIOLATIONS OF THE PROVISIONS OF THIS ACT, AND MAKING AN APPROPRIATION THEREFOR," APPROVED MARCH EIGHTEENTH, ONE THOUSAND NINE HUNDRED FIVE, AND ALL ACTS OR PARTS OF ACTS INCONSISTENT HEREWITH.

The people of the State of California do enact as follows:

SECTION 1. The governor shall appoint an officer to be known as state forester, who shall be a trained forester who has had a technical education. He shall devote all of his time to the affairs of his office and shall not engage or be interested in any enterprise having to do in any way with any matter over which his office has jurisdiction. He shall maintain his residence and office in Sacramento, the latter in quarters provided by the state. The state forester shall be a civil executive officer. He shall, with the approval of the governor, appoint a deputy state forester and an assistant state forester, subject to civil service regulations, whose requirements shall be the same as those prescribed for the state forester. The state forester may, with the approval of the state board of control, employ such expert, technical and clerical assistants, and upon such terms as may be consistent with civil service regulations.

Sec. 2. Chapter two hundred sixty-four, laws of nineteen hundred five, being an act entitled "An act to provide for the regulation of fires on, and the protection and management of, public and private forest lands within the State of California, creating a state board of forestry and certain officers subordinate to said board, prescribing the duties of such officers, creating a forestry fund, and appropriating the moneys in said fund, and defining and providing for the punishment of certain offenses for violations of the provisions of this act, and making an appropriation therefor," approved March eighteenth, one thousand nine hundred five, and all acts or parts of acts in conflict with the provisions of this act are hereby repealed.

Sec. 3. The state forester shall receive a salary of three thousand dollars per annum, the deputy state forester shall receive eighteen hundred dollars per annum, and the assistant state forester shall receive sixteen hundred dollars per annum, which shall be paid at the same time and in the same manner as the salaries of state officers are paid. Salaries of expert, technical and clerical assistants shall be fixed by the state forester, with the approval of the state board of control, and their salaries shall be paid from appropriations made for the state forester. The state forester, deputy state forester, assistant state forester, and all employees shall be paid traveling and field expenses which may be incurred in the necessary performance of their official duties, except as otherwise provided by this act.

SEC. 4. It shall be the duty of the state forester to enforce the provisions of this act, to promote the perpetuation, extension and proper management of the forests of California, both public and private. He may upon suitable request give to any persons owning or controlling forest lands aid or advice in the management thereof. The state forester shall have the right to publish the particulars and results of any examination or investigation made by him or his assistants as to any lands within the state, and the advice given to any person who has applied for his aid or advice. Any recipient of such aid or advice shall be liable to the state forester for the necessary expenses of travel and subsistence incurred by him or his assistants. The state forester shall account for moneys received under this section as the state board of control may direct.

SEC. 5. For the prevention and suppression of forest fires the state forester shall,

(*a*) Make and enforce such rules and regulations as may be necessary and proper for the organization, maintenance, government and direction of the fire protective system provided for in this act.

(*b*) Divide the state into such number of suitable and convenient fire districts as in his judgment may be necessary.

(*c*) Appoint a district fire ranger for each of such fire districts to serve during the seasons when fires are liable to occur at a salary of not to exceed one hundred dollars per month and necessary expenses. Said district fire rangers shall, under the direction of the state forester, have charge of the fire fighting system and men in such districts; and shall be charged with the duty of preventing and extinguishing forest fires and with the performance of such other duties as may be required by the forester.

(*d*) Provide all proper fire-prevention and fire-fighting implements and apparatus, organize fire companies and establish observation stations and employ men to attend them in all fire districts established as herein provided; construct and maintain telephone lines and provide such other means of communication as shall be necessary to prevent and extinguish forest fires.

Sec. 6. For the purpose of cooperating with federal, county, municipal and private agencies for fire protection, forest management, reforestation and afforestation the state forester may,

(*a*) Enter into agreements with the Federal government, under such terms as he deems advisable or as may be provided by law, and renew, revise or terminate such agreements, for the purpose of maintaining a fire patrol system for the prevention and suppression of any forest fires in any timber, brush, grass or other inflammable vegitation or material; *provided*, that the expenses incurred by the terms of said agreements shall be paid from the appropriation or funds available for forest fire protection.

(*b*) Whenever any county or municipality shall make any appropriation for the prevention and suppression of forest fires on any lands within said county or municipality, or for the protection and forest management of any lands over which such county or municipality has jurisdiction, or for reforestation or afforestation on lands within said county or municipality, the state forester may, with the approval of the state board of control, enter into agreements with such county or municipality for said purposes on such terms and under such considerations as he deems wise.

Sec. 7. Where owners of land, or any organization, shall maintain a fire patrol for the prevention and suppression of forest fires the state forester may designate such patrolman as special fire ranger and give to him, for the protection of lands patrolled by him or adjacent thereto, all the rights and powers of district fire rangers as herein provided; and such special fire rangers shall be paid wholly by such owners or organizations or as may be provided for by section six of this act.

Sec. 8. The state forester shall appoint, in such number and localities as he deems wise, public-spirited citizens to act as voluntary firewardens. The state forester, his deputy and assistant and all firewardens provided for in this act shall have the powers of peace officers to make arrests without warrant, for violation of any state or federal forest law, and no firewarden shall be liable to civil action for trespass committed in the discharge of his duties. The firewardens shall promptly report to the state forester all fires occurring within their respective localities and shall take immediate and active steps toward their extinguishment, report any violation of the forest laws, and assist in apprehending and convicting offenders.

SEC. 9. Any person who has knowledge of a forest fire shall report as soon as possible to the nearest firewarden or the state forester, at Sacramento, the location of such fire as accurately as can be determined from the point of discovery. The charges for telephone reports made to the firewarden, and telephone and telegraph reports made to the state forester will be honored by the state forester.

SEC. 10. The state forester shall prepare and print for public distribution the forest laws of California; and shall annually print and distribute the names and addresses of all district fire rangers, special fire rangers and voluntary firewardens in the state. He shall also furnish for distribution appropriate fire warning notices which shall be posted by the rangers and wardens as the state forester may direct. Fire warning notices prepared by private agencies and approved by the state forester shall, when posted, be subject to the provisions of this section. It shall be unlawful for any person to destroy, deface, remove or disfigure any sign, poster or warning notice posted under the provisions of this act.

SEC. 11. To the end that the forests, ground cover, ranges and wild life may be protected against destruction by forest fires, and the public interest safeguarded, the state forester and his assistants may enter upon any lands in the state for the purpose of inspection and examination relative to the proper methods of fire prevention, and may thereafter advise the owner or occupant of such lands in respect thereto.

SEC. 12. The state forester, his assistants, employees and those acting under his direction shall not be liable for trespass while acting in the performance of their duties.

Sec. 13. Every person who starts a camp or other fire for cooking, obtaining warmth or any industrial purpose upon or in the vicinity of any land covered wholly or in part by forests, brush, grass or any other inflammable vegetation shall, before lighting the same, clear the ground of all inflammable material within a radius of six feet from the fire, and shall totally extinguish the fire before leaving the place.

Sec. 14. Any person who shall wilfully or maliciously set fire to any woods, forest, timber, brush, or any inflammable vegetation whatsoever within this state with intent that the property of another shall be injured thereby, shall be guilty of a felony, and upon conviction thereof, shall be punished by imprisonment in the state prison for not less than one year nor more than ten years.

Sec. 15. Any person who sets on fire, or causes to be set on fire, any woods, brush, grass, grain, stubble, or other material being or growing on any lands not his own, without permission from the owner, or who wilfully or negligently allows fire to escape from his own land, or anyone who sets any fire on his own land or another's and allows it to escape from his control without extinguishing it, or using every effort to do so, shall be punished by a fine of not less than fifty dollars, nor more than one thousand dollars, or imprisonment in the county jail for not less than one month, nor more than one year; *provided*, that it shall be lawful to build camp fires as provided by section thirteen of this act on any uninclosed lands, the owner of which has not forbidden the building of such camp fires thereon by personal notice or by posting such prohibition in conspicuous places; *and provided, further*, that nothing in this section shall apply to the setting of a back fire, in good faith, to prevent the progress of a fire then burning.

Sec. 16. From May fifteenth until October fifteenth of each succeeding year hereafter it shall be unlawful for any person, or employee thereof, to use or operate any locomotive, logging engine, portable engine, traction engine or stationary engine using fuel other than oil, in or near forest or brush land within this state, unless such engine be equipped with an efficient spark arrester and an efficient ash pan which are kept in constant use and repair during the operation of such engine.

Sec. 17. All persons engaged in logging within this state or permitting logging upon their lands within this state, shall each year burn their annual slash, by which is meant the tops and inflammable refuse left after lumbering, that may carry fire or cause it to spread, at such times and in such manner and with such provision for help as will confine the fire to their own lands, and, if such burning is done between May fifteenth and October fifteenth of any one year, shall clear a fire guard of not less than thirty feet surrounding the entire area last logged over and, in constructing this fire guard, shall cut down all dead trees and snags over twenty feet high encountered on the line of the fire guard. Builders of trails, roads, or railroads in this state shall immediately destroy or remove all inflammable material resulting from constructing or clearing for such improvements. All burning under the provision of this section shall be in accordance with the provisions of section fifteen of this act.

Sec. 18. It shall be the duty of every railroad corporation or company operating any railroad within this state to keep its railroad track, and either side thereof, for a distance of one hundred feet on each side of the track or roadbed, so far as it passes through any portion of this state, free from dry grass, weeds or any inflammable debris; and any railroad company or corporation failing to keep its railroad track and each side thereof free as above specified, shall be liable for any damages which may occur from fire emanating from the operation of such railroad, and a neglect to comply with the provisions of this section shall be prima facie evidence of negligence on the part of any such railroad company or corporation. But no railroad company or corporation shall be required to keep free as above specified any land not a part of its right of way.

Sec. 19. Hereafter, all companies, corporations or persons, engaged in operating any railroad wholly or in part in this state, shall be liable for the destruction of, or injury to, any property, real or personal, which may be caused by fire, or result from any locomotive, engine, machinery, train, car, or other thing used upon said railroad, or in the operation thereof, or which may result from or be caused by any employee, agent or servant of such corporation, company or person upon or in the operation of such railroad, and the owner of any such property, real or personal, which may be destroyed or injured, may recover all such damage to said property by suit in any court, in the county where the damage occurred, having jurisdiction of the amount of such damage, and upon the trial of any such action or suit for such damage it shall not be lawful for the defendant in such suit or action to plead or prove as a defence thereto, that the fire which caused such injury was not the result of negligence or carelessness upon the part of such defendant, or of its employee, agent or servant; but in all such actions, it shall only be necessary for the owner of such property so injured to prove that the fire which caused or resulted in the injury originated or was caused by the operation of such railroad, or resulted from the act of an employee, agent or servant of such defendant, and if the plaintiff recover in such suit or action, he shall also recover costs, the same to be ascertained from the evidence in the case by the court or jury trying the same; *provided,* that the penalty prescribed by section thirty-six of this act shall apply only when such employee, agent or servant is in the discharge of his duty as such; *and, provided further,* that said action for damages be brought by the party injured within two years next ensuing after it accrues; *and, provided further,* that the liability herein imposed shall inure solely in favor of the owner or mortgagor of the property so damaged or destroyed by fire; and the same shall not pass by assignment or subrogation to any insurance company that has written a policy thereon; *and, provided further,* that nothing in this act shall be held to apply to or in any manner effect any right which has accrued prior to the passage hereof or any suit now pending, or which may hereafter be brought to enforce a right heretofore accrued.

Sec. 20. It shall be the duty of every railroad corporation or railroad company operating any railroad within this state to plough as a fireguard not later than July first of each year, upon each side of its line of railroad, a continuous strip of not less than six feet in width, which said strip of land shall run as near as possible parallel with said line of railroad, and be ploughed in such a good and workmanlike manner as to effectually destroy and cover up the vegetation thereon and be sufficient to prevent the spread of fire, and in addition thereto every such railroad corporation or railroad company shall cause to be burned, not later than August first of each year, all the dry grass and other inflammable vegetation lying between the said ploughed strips and the track of said railroad; and the outer line of said strips of ploughed land shall be upon the outer line of such railroad corporation or railroad company's right of way, or if upon land owned by said corporation or company, one hundred feet on either side from the center of the track or outer track; *provided*, that such fireguard so to be ploughed need not be constructed within the limits of any town or city, nor along that portion of a railroad which runs through rough mountains, or on other lands where ploughing would be impracticable; but that the provisions herein respecting the burning of a strip on each side as above specified shall be duly complied with whenever any vegetation is found along such line of road.

SEC. 21. Any railroad corporation or railroad company failing to comply with the provisions of section twenty of this act shall be liable to pay a penalty of two hundred dollars for each and every mile or fractional part thereof of such strip of land as it neglects to plow on either side of the line of its railroad in this state, in each and every year as aforesaid, the same to be collected in an action of debt in any court of competent jurisdiction, in the name of the people of the State of California, and when collected it shall be paid into the school fund of the county wherein the cause of action accrued. The said action shall be brought within three years next after it accrues.

SEC. 22. Every railroad corporation or railroad company operating any railroad or part thereof within this state shall, subject to the approval of the state forester, equip and maintain in good condition an efficient spark arrester and a suitable ashpan on every locomotive engine owned or operated by such corporation, except such engines as are operated by oil fuel or electricity; and shall require its employees operating such engines to exercise sufficient care to keep such devices in good order and to prevent the escape of live coals or sparks which may cause fires along the right of way.

Sec. 23. Each railroad corporation or railroad company owning or operating a railroad wholly or in part within this state shall be responsible in damages to every person and corporation whose property may be injured or destroyed by fire communicated directly or indirectly by any of the locomotive engines in use upon the railroad owned or operated by such corporation or company, and each such railroad corporation or railroad company shall have an insurable interest in the property upon the route of the railroad owned or operated by it and may procure insurance thereon in its own behalf for its protection against such damages.

Sec. 24. Within thirty days after this act takes effect, and not later than July first of each succeeding year thereafter, any person, firm or corporation cutting wood or lumber on property adjacent to the right of way of any railroad within this state shall dispose of the slash caused by such cutting in such a manner that the inflammable material shall not remain on the ground within twenty-five feet of any railroad right of way. Any operator of wood or timber on such land, or any owner of such land where cutting is done may be fined not more than ten dollars for each acre of such land or fraction thereof from which the inflammable material is not properly disposed of within sixty days from the cutting of the trees or brush thereon; *provided*, that any owner or operator who cuts wood or timber during the winter, after November first, shall have until May first next succeeding to remove the slash in accordance with the provisions of this section; *and, provided, further,* that if such slash is destroyed by burning, such burning shall be done in accordance with the forest laws of the State of California.

SEC. 25. Whenever an arrest shall have been made for violation of any provision of this act, or whenever any evidence which shows with reasonable certainty any such violation shall have been lodged with him. the district attorney for the county in which the criminal act was committed must prosecute the offenders with all diligence and energy. If any district attorney shall fail to comply with the provisions of this section, action against him shall be prosecuted by the attorney general.

SEC. 26. Every person in control of any public or private sanitarium, health resort, pleasure resort, summer camp or hotel conducted for profit and soliciting public patronage, situated in or near any forest or brush covered area, shall file with the state forester at Sacramento the name and post office address of said establishments, the name and post office address of the person owning and the name and post office address of the person controlling said establishments and the number of people for whom lodging is provided in said establishments. The state forester shall cause an investigation of all properties upon which said establishments are located to determine whether any such property by virtue of its location, condition or lack of protection, constitutes a forest fire menace likely to endanger human life. The state forester may issue a certificate of protection whenever, in his judgment, such certificate is deserved; and he may cause to be published the name and post office address of any public or private sanitarium, health resort, pleasure resort, summer camp or hotel conducted for profit and soliciting public patronage and the name and post office address of the person controlling or the person owning any of said establishments when, after an investigation has been made, the state forester determines that the property, by virtue of its location. condition and lack of protection, constitutes a forest fire menace and is likely to endanger human life; *provided*, the person controlling or the person owning said establishments has failed to take such precautions as the state forester deems necessary.

SEC. 27. Every person operating any donkey engine within a forested area of this state shall, within thirty days after this act takes effect, submit a report to the state forester showing the number and location of, and the kind of fuel used in such donkey engines as are being operated by such person; and every person operating any donkey engine within a forested area of this state shall, not later than the first day in March of each succeeding year thereafter, submit a report to the state forester showing the number of donkey engines, the kind of fuel used in each donkey engine, and the change of location of any donkey engine so operated by such person; *provided,* that the change of location need not be reported unless such change necessitates a different route of travel for the inspection of any donkey engine whose location is so changed.

Sec. 28. Every person owning any timber land or cut-over timber land within this state shall, within thirty days after this act takes effect, submit to the state forester accurate data showing, on plots to be provided by the state forester, and in terms of government survey, the location and acreage of timber land and the location and acreage of the cut-over timber land owned by such person. And every person owning any timber land or cut-over timber land within this state shall, not later than January first of each succeeding year thereafter submit to the state forester accurate data showing, on plots to be provided by the state forester, and in terms of government survey, the transfer of any timber land or cut-over timber land, its location and acreage; and in the same manner, report the location and acreage of timber land cut over during the previous year.

Sec. 29. Every person operating a sawmill or shingle mill in this state shall, not later than January first, nineteen hundred sixteen, and not later than January first of each succeeding year thereafter, submit an annual report to the state forester, giving the amount in feet board measure of the lumber sawed, and the number of bundles of lath and shingles sawed, and the number of ties sawed.

Sec. 30. The state forester may establish and maintain a nursery for the propagation of forest tree seedlings on such lands as may be donated to or placed at the disposal of the state for such purpose; *provided*, that the state shall make no compensation for the use of said lands. He may distribute seeds and seedlings to counties, municipalities, schools, land owners, and citizens of the state, under such conditions and restrictions as he may deem advisable. The cost of construction, care and maintenance of nurseries established under the provisions of this section shall be paid from the appropriation made for forest nurseries.

SEC. 31. Such publications of the state forester as shall be designated by the state board of control may be sold by the state forester at a price not less than the cost thereof; and he may upon suitable request prepare publications for clubs and associations for their distribution relative to the prevention of forest fires provided such organizations defray the cost thereof. Any amounts received from such sales shall be paid into the state treasury and be credited to the state forester's appropriation for printing and binding.

SEC. 32. In addition to the penalties provided in this act, the United States, state, county, or any owner, public or private, whose property is injured or destroyed by fires in violation of this act, may recover in a civil action double the amount of damages suffered if the fires occurred through wilfulness, malice or negligence; but if such fires were caused or escaped accidentally or unavoidably, civil action shall lie only for the actual damage sustained as determined by the value of the property injured or destroyed, and the detriment to the land and vegetation thereof. Persons causing fires by violations of this act shall be liable in action for debt to the full amount of all expenses incurred in fighting such fires.

SEC. 33. Wherever in this act the performance or nonperformance of any act or thing is a violation of this act, the person, or the officer, member, manager, agent, director, or employee of any fire association, or corporation who shall direct the performance or nonperformance of such act or thing is likewise and in the same manner guilty of a violation of this act, and shall be punished in a like manner as the person actually performing such act or thing.

SEC. 34. All moneys received as penalties for violations of the provisions of this act, less the cost of collection, and not otherwise provided for, shall be paid into the county treasury of the county in which the violations were committed.

SEC. 35. (*a*) The term "person" as used in this act means a person or firm or corporation or association or a group of persons, firms, corporations, or associations.

(*b*) The term "forest fire" as used in this act means any fire burning uncontrolled on any lands covered wholly or in part by timber, brush, grass, or any other inflammable vegetation.

(*c*) The term "back fire" as used in this act means a fire started in good faith, and allowed to burn only in the direction of and to control a forest fire.

(*d*) The term "slash" as used in this act means the debris resulting from logging or wood cutting.

(*e*) The term "forest fire menace" as used in this act means lands covered wholly or in part by inflammable vegetation in which fire is likely to start and, when started, is likely to endanger human life before available forces can control it.

SEC. 36. Any person, firm or corporation violating any provisions of this act shall, unless specifically designated herein, be guilty of a misdemeanor and be punished by fine not to exceed five hundred dollars or by imprisonment in the county jail not to exceed six months, or by both such fine and imprisonment.

SEC. 37. The state forester shall submit a biennial report to the governor on the accomplishments under the provisions of this act, and make recommendations for the further development of a state forest policy.

SEC. 38. All acts or parts of acts inconsistent with the provisions of this act are hereby repealed.

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Amended in Assembly April 24, 1915.

Amended in Assembly April 21, 1915.

ASSEMBLY BILL No. 491

INTRODUCED BY MR. ENCELL,

JANUARY 21, 1915.

REFERRED TO COMMITTEE ON CONSERVATION.

AN ACT

CREATING A STATE BOARD OF FORESTRY AND PROVIDING FOR THE QUALIFICATIONS AND DUTIES OF THE MEMBERS OF SAID BOARD AND THE PAYMENT OF THEIR EXPENSES; PROVIDING FOR THE APPOINTMENT OF A STATE FORESTER AND PROVIDING FOR THE APPOINTMENT OF A PROPER PERSON THEREFOR; PROVIDING FOR THE APPOINTMENT OF A DEPUTY AND AN ASSISTANT STATE FORESTER AND FOR THE SALARIES OF SUCH FORESTER, DEPUTY FORESTER AND ASSISTANT FORESTER; PROVIDING FOR THE APPOINTMENT OF TECHNICAL AND OTHER ASSISTANTS AND FOR THEIR COMPENSATION; PROVIDING FOR THE DUTIES OF THE STATE FORESTER, DEPUTY STATE FORESTER, ASSISTANT STATE FORESTER AND OTHER ASSISTANTS; PROVIDING FOR COOPERATION WITH LAND OWNERS, COUNTIES AND OTHERS IN FOREST PROTECTION; PROVIDING FOR A SYSTEM OF STATE AND PRIVATE FOREST FIRE PROTECTION AND FOR THE EMPLOYMENT OF FIRE WARDENS; PROVIDING FOR THE SUMMONS OF CITIZENS TO ASSIST IN FIGHTING FOREST FIRES; PROVIDING FOR THE ISSUANCE OF PERMITS FOR BURNING BRUSH, INFLAMMABLE DEBRIS, OR RUBBISH; PROVIDING FOR THE INSPECTION OF FOREST AREAS; DECLARING CERTAIN DANGEROUS AREAS AND FOREST FIRES TO BE PUBLIC NUISANCES; PROVIDING FOR NOTICE TO OWNERS AND

OTHERS OF THE EXISTENCE OF SUCH NUISANCE AND FOR THE ABATEMENT THEREOF BY SUCH OWNER OR OTHERS OR BY THE STATE FORESTER; PROVIDING FOR A LIEN UPON THE PROPERTY OF SUCH OWNER FOR THE COST OF SUCH ABATEMENT; EXEMPTING CERTAIN CLASSES OF OWNERS FROM THE LIENS CREATED BY THIS ACT; PROVIDING FOR THE FORECLOSURE OF SUCH LIENS; PROVIDING FOR THE PAYMENT INTO COUNTY TREASURIES OF ALL OF MONEYS RECOVERED UNDER THE PENAL SECTIONS OF THE FOREST LAWS OF THIS STATE; MAKING CERTAIN VIOLATIONS OF THE FOREST LAWS OF THIS STATE MISDEMEANORS AND FIXING A PENALTY THEREFOR; DEFINING THE TERM "FOREST"; REPEALING CHAPTER TWO HUNDRED AND SIXTY-FOUR OF THE LAWS OF 1905 AND ALL ACTS AND PARTS OF ACTS IN CONFLICT HEREWITH.

The people of the State of California do enact as follows:

SECTION 1. There is hereby created a state board of forestry consisting of three members, appointed by the governor, within ninety days from the time when this act shall take effect, of whom one shall be familiar with the science of forestry, one shall be familiar with the problems of water and resources, and one shall be familiar with forest and lumber conditions of the state. The board shall advise the governor in all matters pertaining to forestry and forest policy in the state, shall certify to the technical qualifications of the state forester and his fitness for the position, shall report to the governor from time to time as to the effectiveness of the work of the state in forest fire prevention and other forest work, shall investigate complaints made to it or to the governor, shall aid the governor in hearing appeals from the decisions of the state forester, shall make recommendations to the governor in matters of state forest administration or to the legislature in regard to the needs of legislation, and advise the governor in any other forest matters directly or upon request. The board shall elect its own chairman and shall hold meetings at the call of the chairman at such place as he may designate. Regular meetings of said board shall be held semiannually at such time and place as shall be determined by said board. The board shall receive no compensation for services but shall receive necessary field, travel, and office expenses incurred in the performance of official duties, such expenses to be paid from the appropriation made for the board of forestry.

Sec. 2. There is hereby created the office of state forester, the appointee to which office shall be a technically trained forester, familiar with western conditions, and experienced in forest protection and administration. He shall be appointed by the governor [and hold office at the pleasure of the appointing power] upon the certification by the state board of forestry that he is technically qualified and otherwise fitted for the position. The state forester shall maintain his residence and office at the state capital, the latter in quarters provided by the state. The state forester shall be a civil executive officer. He shall with the approval of the governor appoint a deputy state forester and an assistant state forester, [ ] whose qualifications shall be the same as those prescribed for the state forester. The state forester may with the approval of the state board of control employ such expert, technical, and clerical assistants [ ] and may incur necessary office expenses not otherwise provided for. The deputy state forester shall have all the power and duties of the state forester during the state forester's absence.

Sec. 3. The state forester shall receive a salary of three thousand dollars per annum, the deputy state forester shall receive a salary of eighteen hundred dollars per annum, and the assistant state forester shall receive a salary of sixteen hundred dollars per annum. Salaries of expert, technical, and clerical assistants shall be fixed by the state forester, with the approval of the state board of control, and their salaries shall be paid from the appropriation made for the board of forestry. The officers and employees provided for in sections two and three of this act shall be paid traveling and field expenses which are incurred in the necessary performance of their official duties.

Sec. 4. The state forester shall administer all matters pertaining to forestry within the jurisdiction of the state;

appoint, instruct, direct, and supervise fire wardens as provided for in this act; take such action as is authorized by law to prevent and extinguish forest, brush and grass fires; make and enforce such rules and regulations as may be necessary and proper to carry out the provisions of this act and other forest laws of the state; enforce the provisions of this and other state forest laws and prosecute violations of said laws; cooperate with the federal authorities, landowners, counties, and others in forest protection, tree planting, and forest management; carry on investigations which may aid in the development of the science and practice of forestry in the state; publish from time to time information regarding forestry; furnish for distribution appropriate fire warning notices, which shall be posted as the state forester may direct; and prepare biennially a report to the governor on the progress and condition of the state forest work with such recommendations concerning forestry as he may see fit.

SEC. 5. Any person who shall remove, destroy, deface or cover up any notice posted in accordance with the provisions of this act shall be guilty of a misdemeanor. Fire warning notices prepared by private agencies and approved by the state forester shall, when posted, be subject to the provisions of this section.

SEC. 6. In carrying out the work of organized forest fire protection in the state and performing other duties provided by law the state forester is authorized to employ fire wardens, field assistants, and labor, and to purchase necessary field equipment and supplies, provided that the salary of a fire warden or a field assistant shall not exceed one hundred dollars per month in addition to necessary expenses of travel. Fire wardens shall perform such duties as the state forester may direct, in organizing fire prevention work, in fire patrol, in detecting or reporting fires, in securing evidence of violation of the forest laws of the state, in apprehending and convicting offenders, and in any other work necessary to carry out the provisions of this act and other forest laws of the state. The state forester shall appoint, in such numbers and localities as he may deem wise, fire wardens who shall serve voluntarily or under compensation from other sources than the state, such duly appointed fire wardens to have all the powers given to fire wardens under the state laws.

Sec. 7. The state forester, his deputy and assistants, and all fire wardens provided for in this act shall have the powers of peace officers to make arrests without warrant for the violation of any state or federal forest law. The state forester, deputy state forester and assistant state forester shall have power to summon any able-bodied male between the ages of sixteen and fifty to assist in suppressing any forest fire; and the above mentioned officers shall have power to authorize any fire warden to summon any able-bodied male between the ages of sixteen and fifty to assist in suppressing any forest fire within their respective jurisdictions, and whosoever fails to obey such summons from any authorized state officer shall be punished as provided for in section 384 of the Penal Code; and every person who in obedience to such summons assists in extinguishing any forest fire shall be compensated at a rate not to exceed twenty-five cents per hour of service actually rendered.

Sec. 8. Fire wardens shall have authority to issue permits to burn brush, inflammable debris or rubbish under such general rules and regulations as the state board of forestry may prescribe and under such special restrictions regarding the time and circumstances of the burning as shall seem necessary for the safeguarding of life or property. To the end that the forests, ground cover, ranges and wild life may be protected against destruction by forest fires, and the public interest safeguarded, the state forester and his assistants may enter upon any lands in the state for the purpose of inspection and examination relative to the proper methods of fire prevention, and may thereafter advise the owner or occupant of such lands in respect thereto.

The state forester, his assistants, employees and those acting under his direction shall not be liable for trespass while acting in the performance of their duties.

SEC. 9. In order to bring about systematic forest fire prevention throughout the state, the state forester may aid owners in the establishment on their lands of systems of fire protection, may prepare fire plans, may aid in the formation of fire protective organizations, may take such action as is necessary to co-ordinate the fire protective systems of different owners, associations and agencies; may utilize the organization, facilities and equipment authorized under this act in the work of patrol, discovery, reporting and preventing forest **[,]** brush **[**or grass**]** fires, may supervise and direct the work of fire protection and fire fighting, may purchase equipment and supplies necessary for fire prevention, and may, where the public interest requires and if funds are available, employ fire fighters and incur such other expenses as may be necessary to protect life and property in a fire emergency, the cost thereof to be paid from the appropriation for the board of forestry. The state forester is authorized, with the approval of the state board of control and under such terms as he may deem wise, to enter into agreements with persons, firms, associations, or corporations owning or controlling forest, brush or grass lands, or with any other agency interested in the **[**prevention**]** and suppression of forest fires, or with any combination or groups of such persons, firms, associations, corporations or agencies, for the purpose of co-operation in the employment of men and facilities, and for taking other measures for prevention and control of forest, brush or grass fires. The state shall not, however, pay more than one third of the expense incurred for said protection. The state forester is further empowered, with the approval of the state board of control, to enter into agreements with the federal government, with counties, with towns or municipalities, upon such terms as may be deemed advisable, or may be provided by law, for the purpose of co-operating in the prevention and suppression of forest fires. All sums chargeable to the state on account of any co-operative agreement as provided in this section shall be paid from the appropriation for the support of the board of forestry.

SEC. 10. All forest areas containing inflammable debris which by reason of the location or condition or lack of protection thereof may further the spread of fire, or endanger life or property are hereby declared a public nuisance. All persons engaged in logging or permitting logging upon their lands or cutting trees for other purposes shall make and are hereby required to make such disposition of the inflammable slashings and debris as will effectively prevent the spread of fire or the creation of a menace to life and property.

Whenever such a nuisance exists, the state forester shall in writing notify the owner, lessee, the person in control or the agent of such owner or lessee of the land upon which said nuisance is situated, of the existence of said nuisance, and shall require that such nuisance be abated within a period and in a manner specified in such notice. But the state forester may for good cause shown extend the time in which said nuisance shall be abated.

Whenever after due and sufficient notice by the state forester such nuisance remains unabated, the owner, lessee, the person in control, or responsible agent of the owner or lessee of the land on which said nuisance exists, shall be deemed guilty of a misdemeanor and shall be liable to a fine of not more than five hundred dollars and the costs of prosecution for each violation thereof or failure to comply therewith. In event of the fine remaining unpaid, the same shall become a lien on the land in which the nuisance exists. Whenever because of the failure of an owner, lessee or agent responsible the nuisance remains unabated, the state forester may cause the same to be summarily abated and the cost thereof [shall] become a lien on the land on which the nuisance exists.

SEC. 11. Any fire in any forest or on other land burning uncontrolled and without proper measures being taken to suppress it, or which endangers life and property, is hereby declared a public nuisance, and any person, firm, association, corporation or agency owning or controlling land on which such nuisance exists is hereby required to abate it by controlling or extinguishing it. If the person, firm, association, corporation, or agency owning or controlling the land on which such nuisance may exist refuses or neglects to take proper steps to abate such nuisance, he shall be guilty of a misdemeanor and shall be fined not more than one thousand dollars in addition to the costs of prosecution for each offense. Any fine imposed shall become a lien on the land on which the nuisance may have existed. If the owner of land fails to take proper steps to abate the nuisance of a menacing forest fire the state forester may summarily abate such nuisance. The expense of the summary abatement of a nuisance by the state as herein provided for shall be paid from the moneys that may be appropriated for the support of the board of forestry. Any and all expenses incurred for the summary abatement of the nuisance shall be and become a lien on the land upon which such nuisance shall have existed.

Sec. 12. No such lien as is provided for in this law shall be filed or accrue upon the land of any person, firm, association, corporation or agency, who in good faith endeavors to prevent and abate any nuisance mentioned in this act or who maintains a system of forest fire protection approved by the state forester.

Action to foreclose liens upon lands as provided in this law shall be begun within one year. Such liens shall be filed by the state forester or under his direction within ninety days after the expiration of a period required by the state forester for the abatement of the nuisance by the owner, lessee, or responsible agent of the land on which it shall have existed, or within ninety days after action shall have been taken by the state forester to abate the nuisance. Proceedings to the satisfaction of such liens shall be instituted and maintained at the request of the state forester and in the name of the people of the State of California by the district attorney of the county in which said lien exists and the costs shall be recovered in the usual manner.

Sec. 13. Owners, lessees, or persons in control of lands upon which fires may be started or are burning are not relieved by any of the provisions of this act from the duty of extinguishing or controlling such fires; and no such owner or lessee or persons in control, or any person in the employ of such owner or lessee or person in control, shall receive any compensation under this act for extinguishing or controlling fire occurring upon or threatening the lands of such owner or lessee or person in control.

SEC. 14. In addition to the penalties provided by the forest laws, the United States, state, county, or private owners, whose property is injured or destroyed by fires, may recover in a civil action double the amount of damages suffered, if the fires occurred through wilfulness, malice, or negligence; but if such fires were caused, or escaped, accidentally or unavoidably, civil action shall lie only for the actual damage sustained as determined by the value of the property injured or destroyed and the detriment to the land and vegetation thereof.

SEC. 15. All moneys recovered under the provisions of the penal sections of the forest laws of this state shall be paid, less the costs of and compensation for collection, into the treasury of the county in which such money was collected.

SEC. 16. Every firewarden appointed under the provisions of this act shall be provided by the state forester with a badge of authority which shall be produced whenever demand is made for such production.

SEC. 17. Wherever in the forest laws of the state the performance or non-performance of any act or thing is made a misdemeanor, the person, or the officer, member, manager, agent, director or employee of any firm, association, or corporation who shall direct the performance or non-performance of such act or thing is likewise and in the same manner guilty of a misdemeanor and shall be punished in a like manner as the person actually performing or not performing such act or thing.

SEC. 18. For the purpose of this act the word "forest" shall be taken to mean and to comprise lands wholly or in part covered with timber, brush or other similar vegetation.

SEC. 19. Chapter 264 of the laws of 1905 and all acts or parts of acts inconsistent with the provisions of this act are hereby repealed.

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Advisory Pamphlet

on

Camp Sanitation and Housing

Commission of Immigration and Housing
of California

Underwood Building, 525 Market Street
San Francisco, Cal.

Commission of Immigration and Housing of California

UNDERWOOD BUILDING
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July, 1914.

COMMISSION OF IMMIGRATION AND HOUSING
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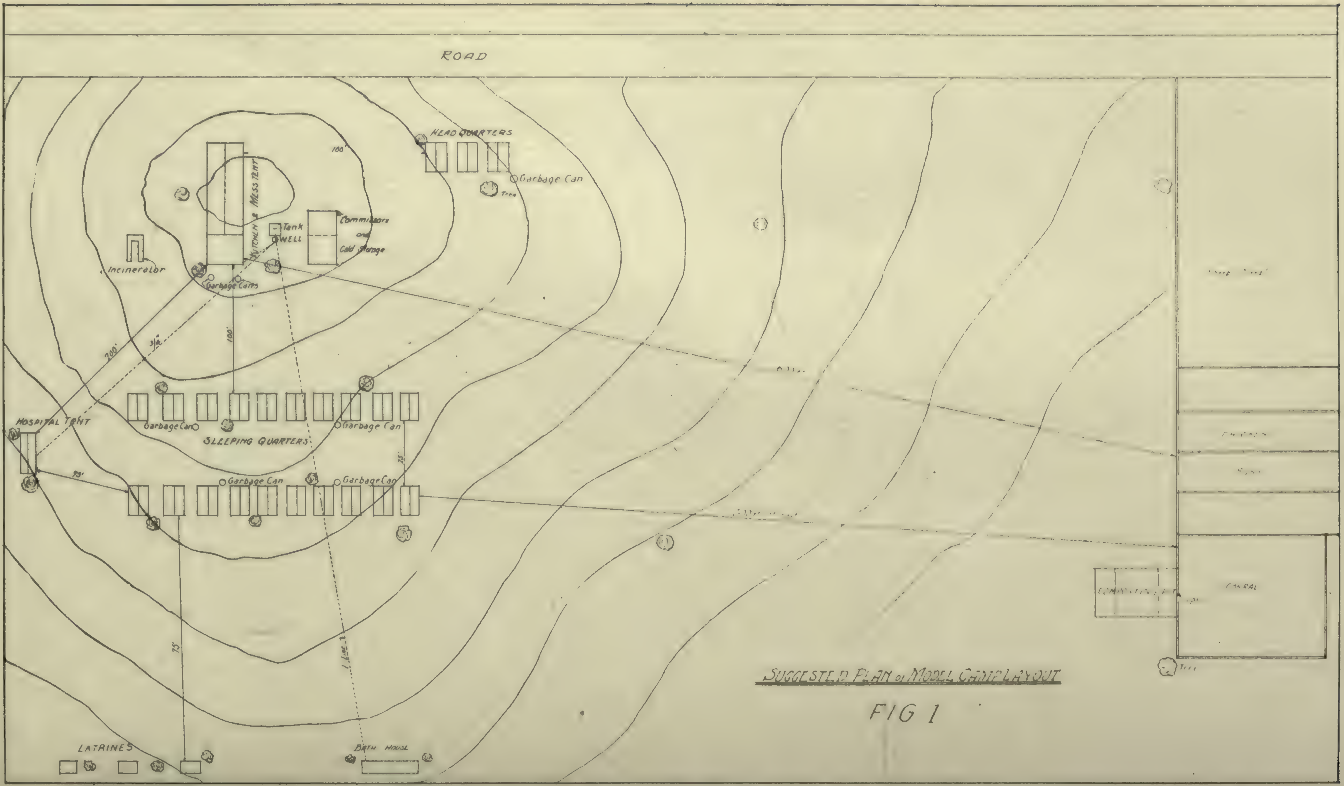


SUGGESTED PLAN OF MODEL CAMP LAYOUT

FIG 1

A suggested layout for model camp, wherever natural situation permits. It is wise to choose high ground for sleeping quarters and dining-room. Toilets and baths should be at a convenient distance from tents. Corrals and animal enclosures should be at least 500 feet distant from living quarters.

TO OWNERS AND SUPERINTENDENTS OF LABOR CAMPS.

On August 3, 1913, a riot occurred on a hop ranch near Wheatland. The Commission of Immigration and Housing after a thorough investigation of the causes which led up to the riot, determined that probably the most important contributory factor was the poor housing and sanitary accommodations afforded the workers. Further investigation made it clear that the Wheatland hop ranch conditions were not exceptional, but that similar insanitary housing conditions prevail pretty generally throughout the labor camps in the State.

Our contact with the employers of labor made it clear to us that the undesirable sanitation was not the result of intentional carelessness but rather a relic of early California days when our people were good naturedly willing to put up with almost any housing conditions. Where we have suggested improvements in housing or sanitation, we have met with hearty cooperation on the part of every camp owner.

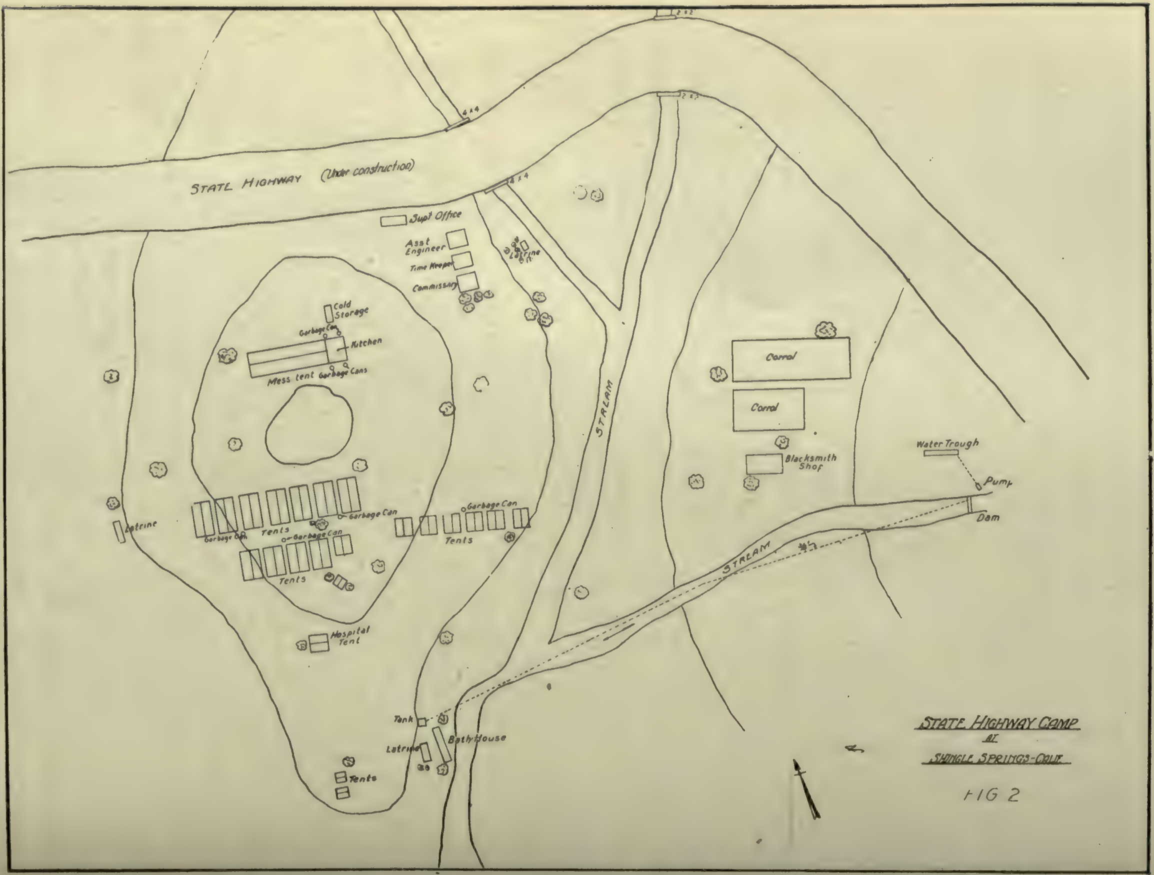
In our desire to be of the greatest possible help to the owner of the labor camp and to the man who must live in it, we have thought it wise to submit in the form of a pamphlet certain suggestions pertaining to the housing of men in camps. This pamphlet has been prepared under the direct supervision of the Chief Sanitary Engineer of the Commission, J. J. Rosenthal, who has received helpful suggestions from the following authorities:

Colonel R. G. Ebert, Department Surgeon, Western Department, United States Army.
W. A. Sawyer, M. D., Director of the Hygienic Laboratory of the California State Board of Health.
William B. Herms, Assistant Professor of Parasitology, University of California, and Officer in charge of Malaria Investigations, California State Board of Health.
Dr. George W. Shaw, Consulting Agriculturist and Land Expert.
Symmes, Means & Chandler, Agricultural Engineers.

These experts have formally expressed their approval of the scheme of this pamphlet and of the several recommendations made therein.

If any portions of this pamphlet are not perfectly clear to you, or if you have a problem in housing or sanitation which we do not cover herein, we invite you to write to our San Francisco office stating your difficulty. Your inquiry will have the personal attention of our Engineering Department. And if we can not handle your problem satisfactorily through the mail, we shall willingly send a personal representative at no expense to you.

COMMISSION OF IMMIGRATION AND HOUSING
OF CALIFORNIA,
Underwood Building, 525 Market Street,
San Francisco.



The layout of the State Highway Construction Camp at Shingle Springs, standardized by the Commission. Sleeping quarters, kitchen and dining tent are located on high ground. Corral is 500 feet away from tents.

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CAMP SANITATION AND HOUSING.

Foreword.

A sanitary camp means an increase in the willingness and efficiency of the labor.

Suppose a camp of 200 men with a pay roll of $400.00 per day: if living conditions are bad and the sleeping accommodations make a reasonable night's rest impossible, if the food is fly infested, and the toilets unclean and revolting, the men become disgruntled and dissatisfied and some become sick. Experience has shown that often under such conditions there will be a 25 per cent loss of working efficiency, or a loss per day of $100.00, or $3,000.00 per month. The sum of $10.00 per day or $300.00 per month will cover easily the cost of good sanitation. This camp therefore can save $2,700.00 per month by installing model living conditions, and do away with the serious handicap of an ever-quitting force. Few employers of unskilled labor realize their loss through the "soldiering" of discontented workers. Petty strikes and a labor force continually quitting, both frequent products of bad camp conditions, often increase the cost of the work beyond the profit.

Practically all disease-carrying house flies breed in manure piles, kitchen refuse, garbage and human excrement.

Flies carry typhoid, dysentery, diarrhea and other intestinal diseases from human excrement to the food, thus spreading disease among the laborers and employers.

Dispose of these breeding and feeding places and you dispose of flies.

Dispose of flies and you dispose of one of the main causes of camp sickness.

Therefore, it is not only to the interest of humanity, but to your own interest to have a sanitary and "livable" camp.

I.

Location of Camp.

1. Every camp should be located on well drained ground. Low places, swamps and wet areas should be avoided, on account of both the discomfort attached to wet quarters and the possibility of affording breeding places for malaria-bearing mosquitoes.

II.

Layout of Camp.

1. Tents and portable houses should be arranged in rows so that the surroundings can be kept clean easily.

2. The kitchen, mess and commissary houses should be at least 100 feet from the sleeping quarters.

3. The stable, sheep corral and chicken coops should be at least 600 feet from the kitchen and mess house, and at least 500 feet from the sleeping quarters.

4. The toilets should be placed at least 75 feet from the sleeping quarters and 200 feet from the kitchen and mess house.

5. If incinerators for kitchen garbage are used, they should be located near the kitchen.

6. The hospital tent or house should be 200 feet from the kitchen and mess tent, and 75 feet from the sleeping quarters.

Figure 1 shows a suggested layout of a model camp.

Figure 2 shows the layout of the State Highway Construction Camp at Shingle Springs, standardized by the Commission.

Figure 3 (page 10) shows the main camp layout of the Durst Bros.' hop ranch at Wheatland, planned by the Commission.

III.

Water Supply.

1. A plentiful supply of wholesome water for drinking and bathing should be supplied.

2. In every case, the supply must be absolutely free from organic contamination.

3. Ground water supplies from wells should be covered at the top, to insure against surface pollution.

4. Old wells in questionable positions with reference to surface drainage should be condemned and, whenever there are no wells free from pollution upon a permanent camp site, new wells should be sunk.

5. Whenever it is necessary to erect a camp at a place where the only water available is known to be contaminated or is even of questionable quality, such water should be purified by boiling.

6. All privy vaults and cesspools should be at least 200 feet from the water supply and so located that pollution is impossible.

Figure 4 shows how a well may become polluted by the contents of a privy vault. (See page 11.)

Figure 5 shows how a well located on high ground may be polluted by the contents of a cesspool lower down.

Figure 6 shows how a cesspool located on high ground may fail to pollute a well lower down.

7. Frequent analyses of the water in use should be made to assure the water's purity.

8. If drinking water is kept in a barrel, the barrel should be cleaned frequently. The water should be drawn from this barrel by a faucet,

and a tight cover kept on the barrel to prevent men from dipping in with a cup and also to prevent insects from entering.

9. The use of individual drinking cups should be encouraged among the employees.

IV.

Tents and Buildings.

1. The tents or portable houses or the more permanent wooden bunk houses used for sleeping quarters, must afford at least 500 cubic feet of air for each person, in conformity with state law, unless there is some permanently open means of ventilation, such as a complete open side of the tent, or building, or permanent open ends or permanent opening at the top.

2. If wooden bunk houses are used, there should be ample window space. Doors and windows should be screened in warm weather, to protect the occupants from flies and mosquitoes.

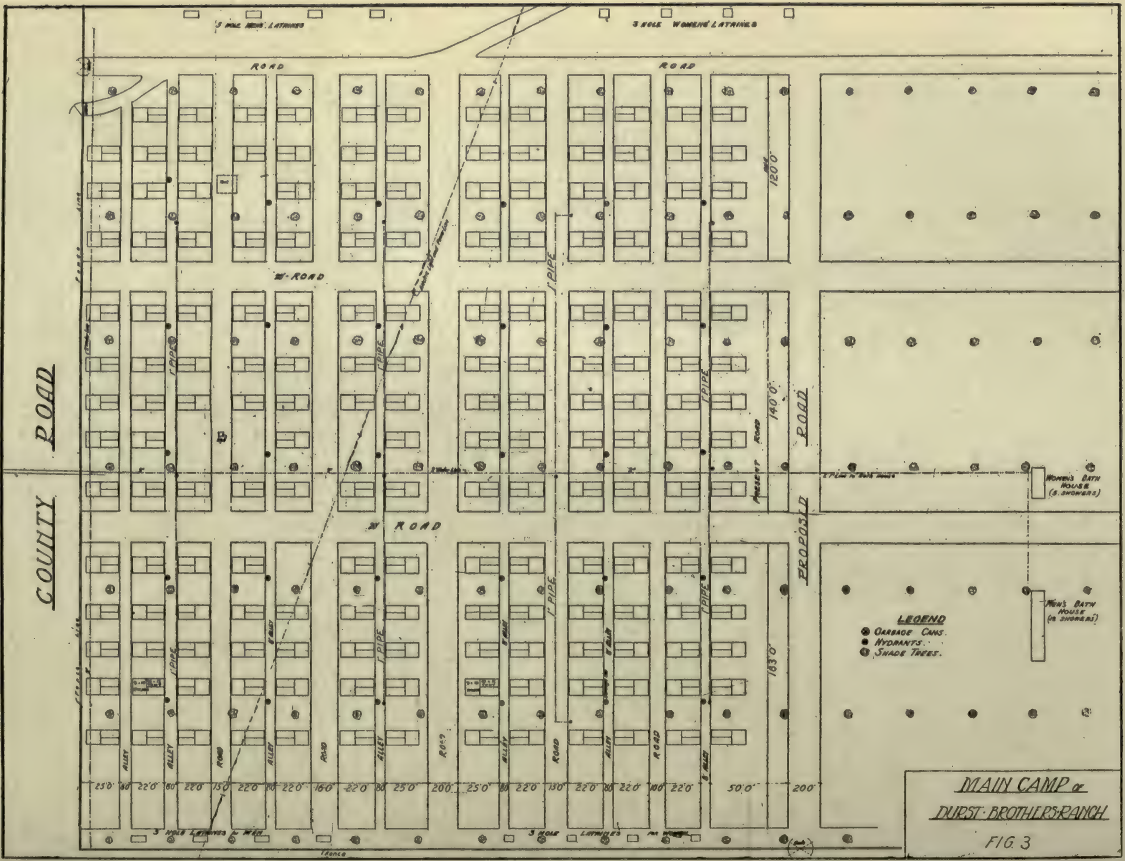
3. There should be proper drainage around the tents and buildings, to keep the floors dry. In winter camps, tents and buildings should have wooden floors at least 12 inches above the ground.

4. Floors in bunk houses or tents should be swept at least twice a week. Dry sweeping should be discouraged.

5. It is strongly recommended that iron bunks be used. These are easily made vermin proof and are acknowledged to be much more comfortable than straw bunks. But if bunks with straw bedding are used, the straw or hay should be changed at least once a week.

Standard Sizes of Tents, Showing Number of Occupants Permitted.

Size of tent	Height of walls	Number of occupants permited	Size of tent	Height of walls	Number of occupants permited
7 x 9½	3	1	18 x 20	5	6
9½ x 9½	3	1	18 x 24	5	7
9½ x 12	3	1	18 x 30	5	9
9½ x 14	3	1	18 x 35	5	10
12 x 12	3½	2	18 x 40	5	12
12 x 14	3½	2	20 x 24	5	8
12 x 16	3½	2	20 x 30	5	10
12 x 18	3½	2	20 x 35	5	11
14 x 14	4	3	20 x 40	5	13
14 x 16	4	3	20 x 50	5	16
14 x 16	3	3	24 x 30	6	14
14 x 18	4	3	24 x 35	6	16
14 x 20	4	4	24 x 40	6	18
14 x 24	4	4	24 x 50	6	23
16 x 16	5	4	24 x 60	6	27
16 x 18	5	4	30 x 40	6	25
16 x 20	5	5	30 x 50	6	32
16 x 24	5	6	30 x 60	6	38
16 x 30	5	7	30 x 70	6	44
16 x 35	5	9	30 x 75	5	44
18 x 18	5	5	30 x 84	5	48



The main camp layout of the Durst Bros. hop ranch at Wheatland, planned by the Commission. The tents are arranged in military style, in blocks, with sufficient distance between tents. Water is piped, and hydrants are provided in the streets. Garbage cans are in the alleys. Toilets are on east and west side of camp, near enough for convenience, but not too close. Men's and women's showers are about 140 feet from the camp.

Table above gives the standard sizes of tents, showing the number of occupants permitted in each tent.

Figure 7 shows a 16 x 20 crowded tent occupied by 17 persons. This tent contained double deck bunks, each occupant having about 120 cubic feet of air. This bad condition existed in one of the camps before it was standardized by the Commission.

Figure 8 shows a 10 x 26 triple deck bunk car, crowded with 19 persons, each having about 95 cubic feet of air. This also existed in one of the camps before it was corrected by the Commission.

Figure 9 shows a 16 x 20 tent with 5 single bunks, each occupant having 500 cubic feet of air. This model arrangement is the result of the Commission's work in changing the conditions shown in Figure 7.

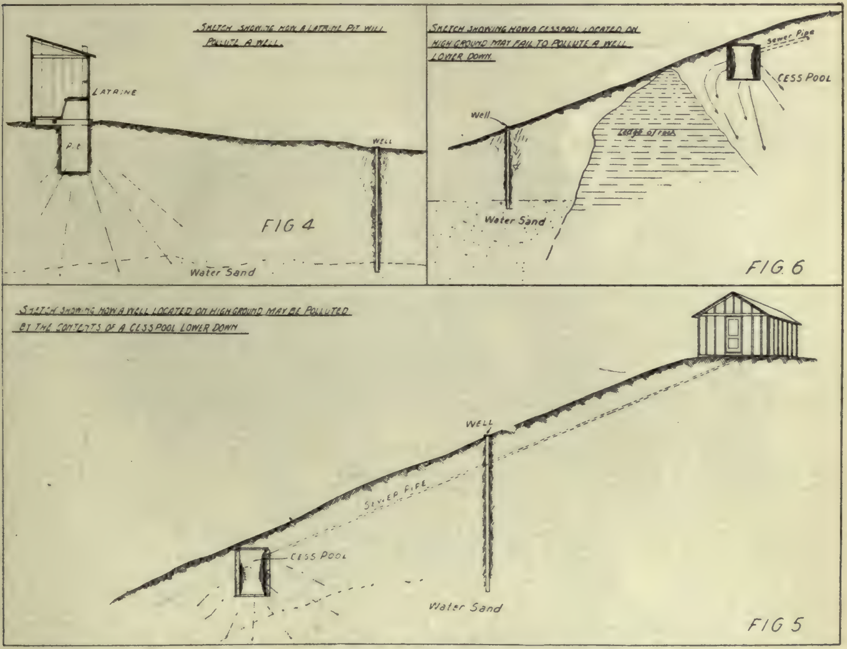

SKETCH SHOWING HOW A LATRINE PIT WILL POLLUTE A WELL.
LATRINE
PIT
WELL
FIG 4
Water Sand
SKETCH SHOWING HOW A CESSPOOL LOCATED ON HIGH GROUND MAY FAIL TO POLLUTE A WELL LOWER DOWN.
Sewer Pipe
CESS POOL
Well
Ledge of rock
Water Sand
FIG 6
SKETCH SHOWING HOW A WELL LOCATED ON HIGH GROUND MAY BE POLLUTED BY THE CONTENTS OF A CESSPOOL LOWER DOWN
WELL
SEWER PIPE
CESS POOL
Water Sand
FIG 5

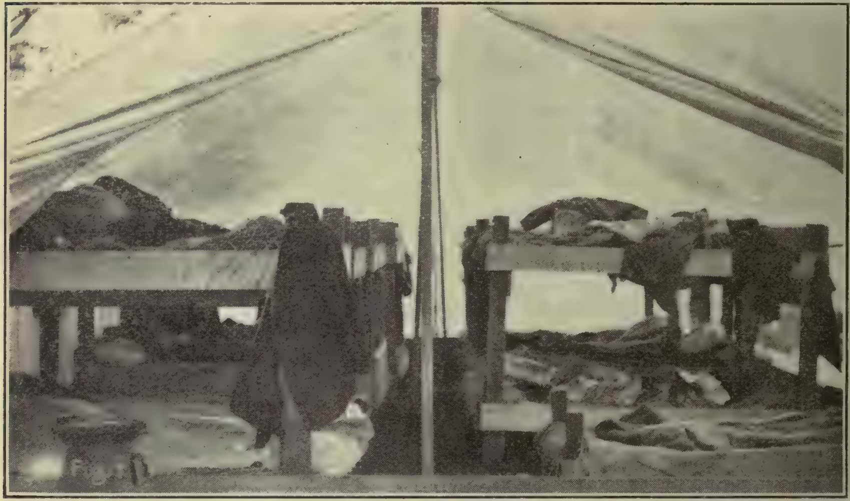
Figure 4 shows how a well may become polluted by the contents of a privy vault. Figure 5 shows how a well located on high ground may be polluted by the contents of a cesspool lower down. Figure 6 shows how a cesspool located on high ground may fail to pollute a well lower down.

6. The following is the law providing for bunks and beds: Statutes of 1913, Chapter 182, Section 2. "Every bunk house, tent, or other sleeping place used for the purpose of a lodging or sleeping apartment in such a camp, shall contain sufficient air space to insure an adequate supply of fresh air for each person occupying such bunk house, tent or other sleeping place. The bunks or beds shall be so constructed as to afford reasonable comfort to the persons occupying such bunks or beds."

7. Mess and cook tents or houses should have all openings screened and the doors should have spring hinges, coils or some other arrangement to close them automatically.

Figure 10 shows a non-flyproof dining tent, as the Commission found it, where thousands of flies entered and infested the food. Conditions of this nature will in the end bring an epidemic of typhoid, dysentery or other intestinal diseases to camps. (See page 14.)

Figures 11 and 12 show the exterior and interior of another dining tent and kitchen as remodeled by the Commission.



A 16 by 20 crowded tent occupied by seventeen persons. This tent contained double deck bunks, each occupant having about 120 cubic feet of air. This bad condition existed in one of the camps before it was standardized by the Commission.

The seating capacity of this mess tent was increased from 80 to 130; and the cost of remodeling same at the State Highway Camp, Shingle Springs, was as follows:

1266 board feet lumber at $16 per thousand	$20 26
243 square feet black wire screen at $0.013	3 16
One tent fly 25 x 26 feet	23 75
Hardware	1 50
Labor	25 00
Total	$73 67

Figure 13 shows a model dining tent (knock-down system), for 52 persons. (See page 16.)

The bill of material for this mess tent and kitchen as shown in Figure 13 is as follows:

30 pieces 2″ x 4″—14′ Oregon pine studs.
9 pieces 2″ x 4″—16′ Oregon pine plates.
14 pieces 2″ x 4″— 9′ Oregon pine rafters.
7 pieces 2″ x 4″—12′ Oregon pine rafter ties.
3 pieces 2″ x 4″—16′ Oregon pine ridge.
5 pieces 2″ x 4″—10′ Oregon pine rafters over vestibule.
6 pieces 2″ x 6″—20′ redwood mud sills.
45 pieces 1″ x 12″—10′ redwood boards.
48 pieces 1″ x 3″—10′ redwood battens.
12 pieces 1″ x 6″—10′ redwood over screen.
70 pieces 1″ x 6″— 7′ Oregon pine tongue and groove for vestibule.
12 pieces 1″ x 12″—10′ Oregon pine, s. 1 s., for shelving.
2 pieces 1″ x 12″—16′ redwood for gable ends.
2 stock doors 2′ 6″ x 6′ 6″ x 1¼″.
2 screen doors 2′ 6″ x 6′ 6″.
1 stock door 3′ 0″ x 6′ 6″ x 1½″.
1 screen door 3′ 0″ x 6′ 6″.
500 square feet galvanized or copper wire screen.
900 square feet canvas for tent covering.
6 pair 6″ strap hinges for doors.
6 spring coils 12″ or 14″ for doors.
7 ridge connections marked "A," and 14—⅝″ x 5″ bolts.
8 corner connections marked "B," and 8—⅝″ x 3″ bolts.
14 rafter connections marked "C," and 28—⅝″ x 5″ bolts.
4 ⅝″ x 5″ bolts for stud connections.
75 square feet 2-ply Malthoid, or equal, roofing, or 9—5′ sheets corrugated galvanized iron.

A 10 by 26 triple deck bunk car, crowded with nineteen persons, each having about 95 cubic feet of air. This also existed in one of the camps before it was corrected by the Commission.

The estimated cost of this mess tent and kitchen is as follows:

	San Francisco	Sacramento	Fresno	Los Angeles
Material	$117 65	$130 72	$156 86	$117 35
Labor	50 00	55 00	60 00	40 00
Total	$167 65	$185 72	$216 86	$157 00

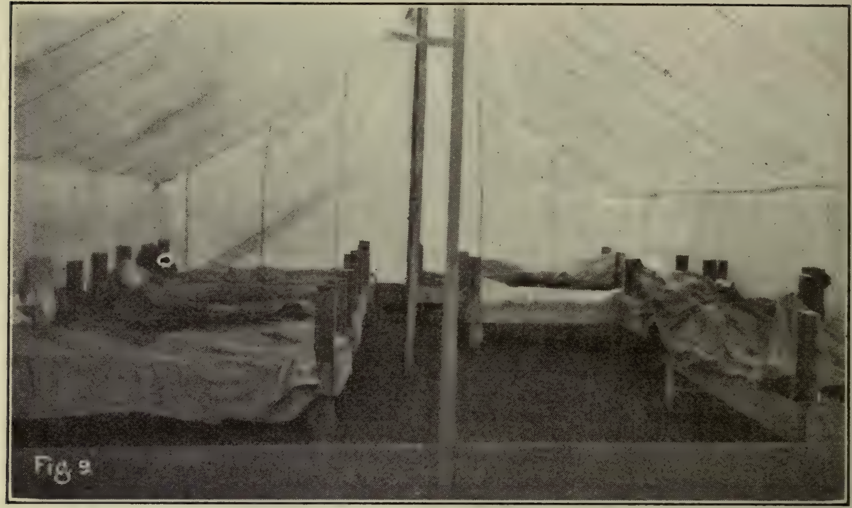


Fig. 9

A 16 by 20 tent, with 5 single bunks, each occupant having 500 cubic feet of air. This model arrangement is the result of the Commission's work in changing the conditions shown in Figure 7.

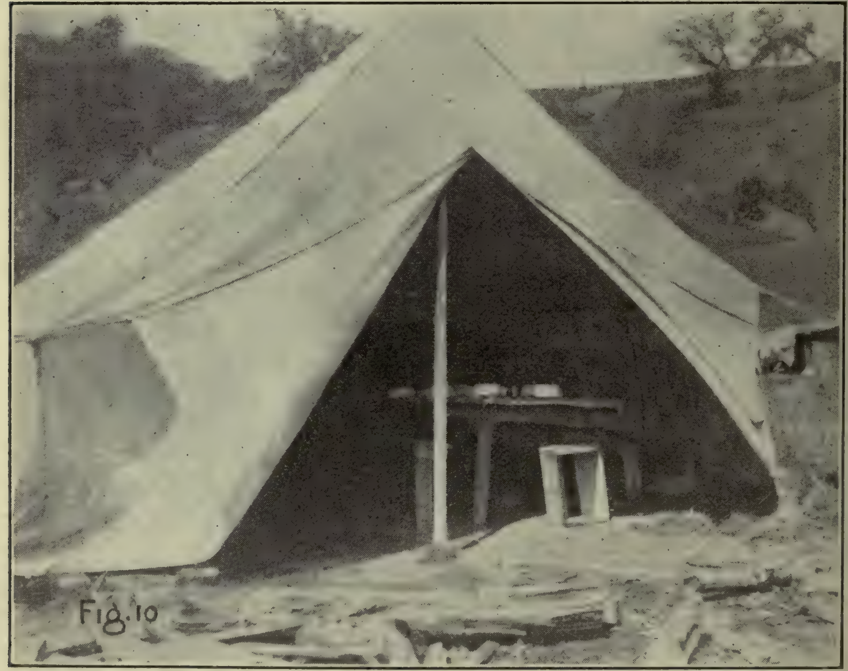


Fig. 10

A non-flyproof dining tent, as the Commission found it, where thousands of flies entered and infested the food. Conditions of this nature will in the end bring an epidemic of typhoid, dysentery or other intestinal diseases to camps.

V.

Kitchen and Mess-house.

1. The kitchen and mess-house should be thoroughly cleaned at least once a week, and the floor should be swept daily. Dry sweeping should be discouraged.

2. All persons engaged in cooking and handling the food should be carefully examined, with particular attention as to whether or not they have suffered from typhoid fever or tuberculosis within recent years.

A recent official investigation into a typhoid outbreak of 93 cases at Hanford, traced the infection to food which had been contaminated during preparation by a woman recently recovered from typhoid.

Mild or ambulatory cases of typhoid fever are frequently unrecognized by a layman and are then as dangerous for infection as the severer cases.

Exterior of dining tent and kitchen, after remodeled by the Commission.

Typhoid infection very frequently takes place in the labor camps because persons preparing the food are ''typhoid carriers.'' It is of record that certain persons though entirely recovered from typhoid have remained carriers and distributers of the germs for years.

The excreta and urine of such a person, who is a carrier of typhoid infection, is full of thousands of germs. If a fly reaches this excreta, his wings and feet are covered with a multitude of these virulent germs and if he touches food, the new infection of a healthy person is completed. This is the medical reason for screened toilets and an efficient disposal of manure and garbage.

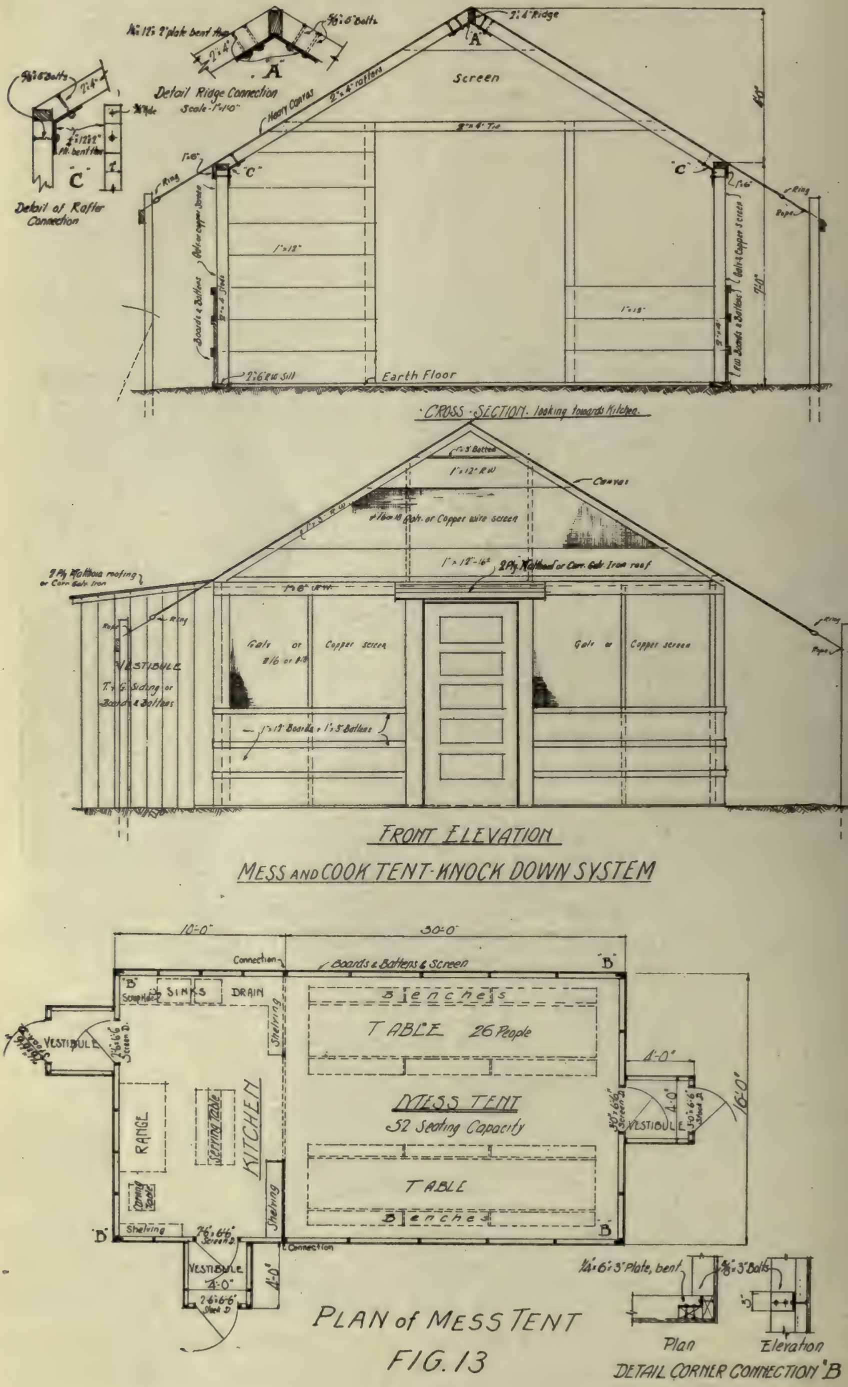


FIG. 13

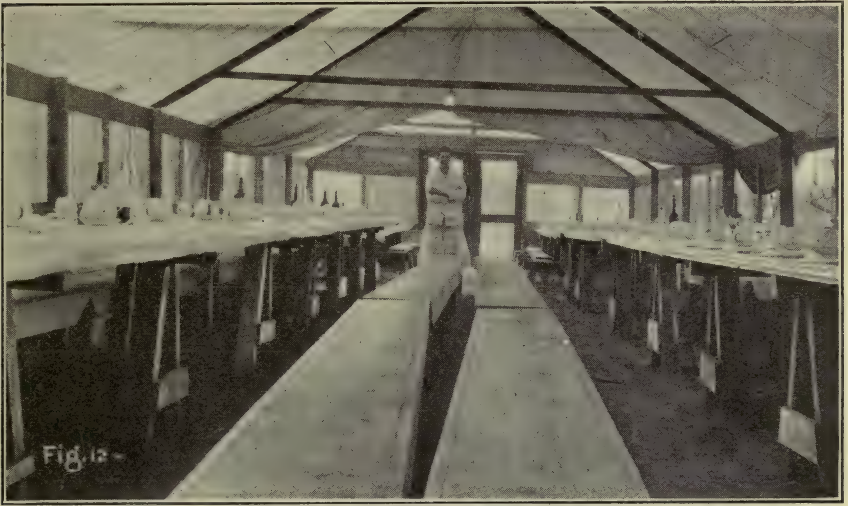
A model dining tent (knock-down system), for fifty-two persons.

Undoubtedly every large California labor camp, practically without exception, has its typhoid carrier or carriers.

3. Any person afflicted with a communicable disease should be kept away from the kitchen and messhouse.

4. In the case of cooks, helpers and waiters, absolute cleanliness of person and clothes should be insisted upon.

5. All perishable food supplies should be protected from putrefaction and insects. In remote localities where ice can not be obtained, a small screened inclosure should be built in the shade and covered with burlap or canvas which should be kept wet in warm weather. This will keep fresh, meats, eggs, butter, milk, etc.



Interior of dining tent, after remodeled by the Commission.

VI.

Garbage and Refuse Disposal.

1. Kitchen garbage and refuse should be kept in fly-proof containers, preferably metal, until permanently disposed of. Such containers should be emptied at least once in two days.

2. Fly-tight receptacles should be provided convenient to the sleeping quarters, for the collection of wastes, such as paper, cast-off clothing, etc.

3. All garbage should be disposed of either by incineration, by burying, or by feeding to hogs. (Hogs should not be allowed within a quarter of a mile from camp.) Garbage should not be fed to chickens, as they will not consume it all, thus affording fly breeding and feeding places.

4. Incinerators for the burning of garbage and wastes can be easily and cheaply constructed.

Figure 14 shows a chimney type incinerator for a camp of 2,000 persons. This can be built of rock, cobblestones or old brick by unskilled labor. Such an incinerator can be built for about $30.00, provided material is available on the ground.

For a permanent camp the incinerator should be built of either concrete or brick and lined with fire brick.

The bill of material for the above incinerator is as follows:

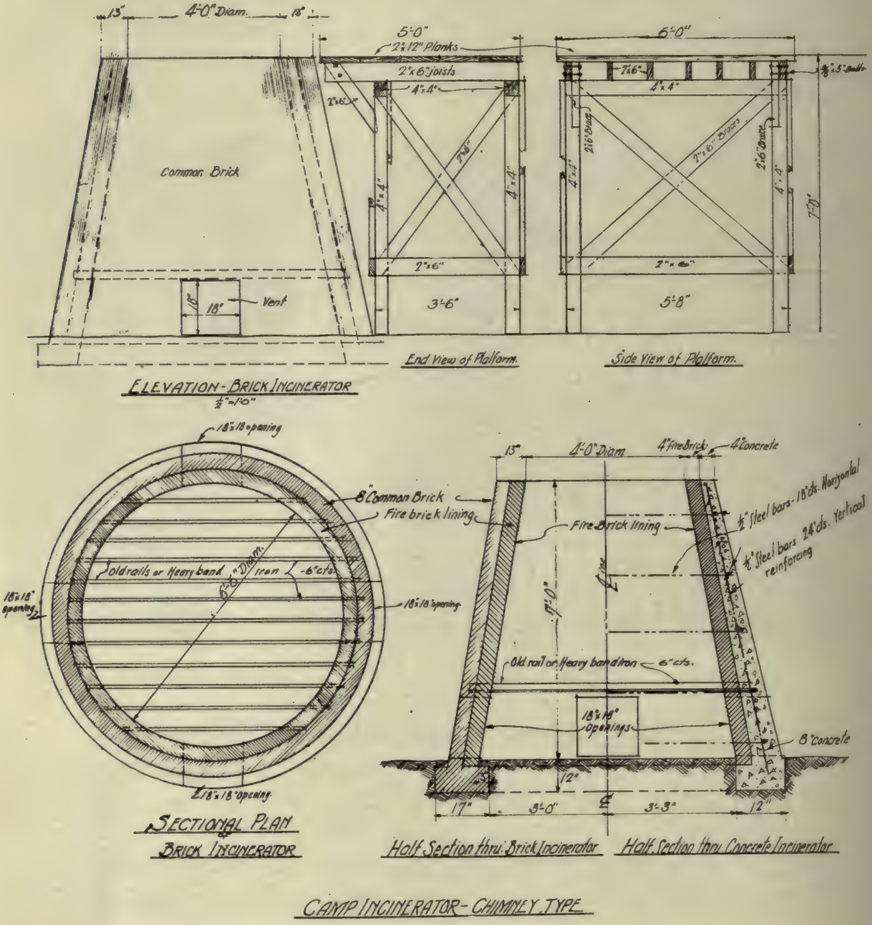


FIG. 14

A chimney type incinerator for a camp of 2,000 persons. This can be built of rock, cobblestones or old brick by unskilled labor. Such an incinerator can be built for about $30.00, provided material is available on the ground.

Brick Type.

800 fire brick.
2,500 common brick.
1,800 pounds grate bars or old rails.
36 cubic feet excavation.

Concrete Type.

24 cubic feet excavation.
128 cubic feet concrete.
120 pounds reinforcing steel.
800 fire brick.
1,800 pounds grate bars or old rails.

Platform Material.

4 pieces 4″ x 4″—7′ redwood posts.
2 pieces 4″ x 4″—6′ redwood girders.
115 lineal feet 2″ x 6″ Oregon pine joists and braces.
30 lineal feet 2″ x 12″ Oregon pine plank floor.
20 lineal feet 2″ x 12″ redwood stair stringers.
30 lineal feet 2″ x 12″ redwood stair treads.
44 lineal feet 2″ x 4″ Oregon pine braces and supports.
9 lineal feet 2″ x 3″ Oregon pine, s. 4 s., hand rail.
4 ⅝″ x 5″ bolts.
10 pounds 20d nails.

The estimated cost of this incinerator as shown in Figure 14 is as follows:

	San Francisco	Sacramento	Fresno	Los Angeles
Brick type—				
Material	$74 80	$83 40	$86 20	$70 20
Labor	56 70	63 00	64 00	50 00
Total	$131 50	$146 40	$150 20	$120 20
Concrete type—				
Material	$69 10	$89 90	$94 30	$67 35
Labor	65 90	70 00	73 00	45 50
Total	$135 00	$159 90	$167 30	$112 85

Figure 15 shows a stack type incinerator for a camp of 150 people. The pan shown is 8 inches in depth and is used to evaporate liquid slops, while the solid garbage is placed on top of the fuel. By treating the liquid thus separately, a great deal of fuel is saved.

Bill of material is as follows:

Brick Type.

144 fire brick.
330 common brick.
20 cubic feet excavation.
225 pounds of old rail or grate bars.
22 square feet No. 24 galvanized iron for stack.

Concrete Type.

20 cubic feet concrete.
144 fire brick.
20 cubic feet excavation.
225 pounds old rails or grate bars.
22 square feet No. 24 galvanized iron for stack.
1 piece wrought iron plate, 26 x 26 inches.
21 square feet sheet metal for pan.

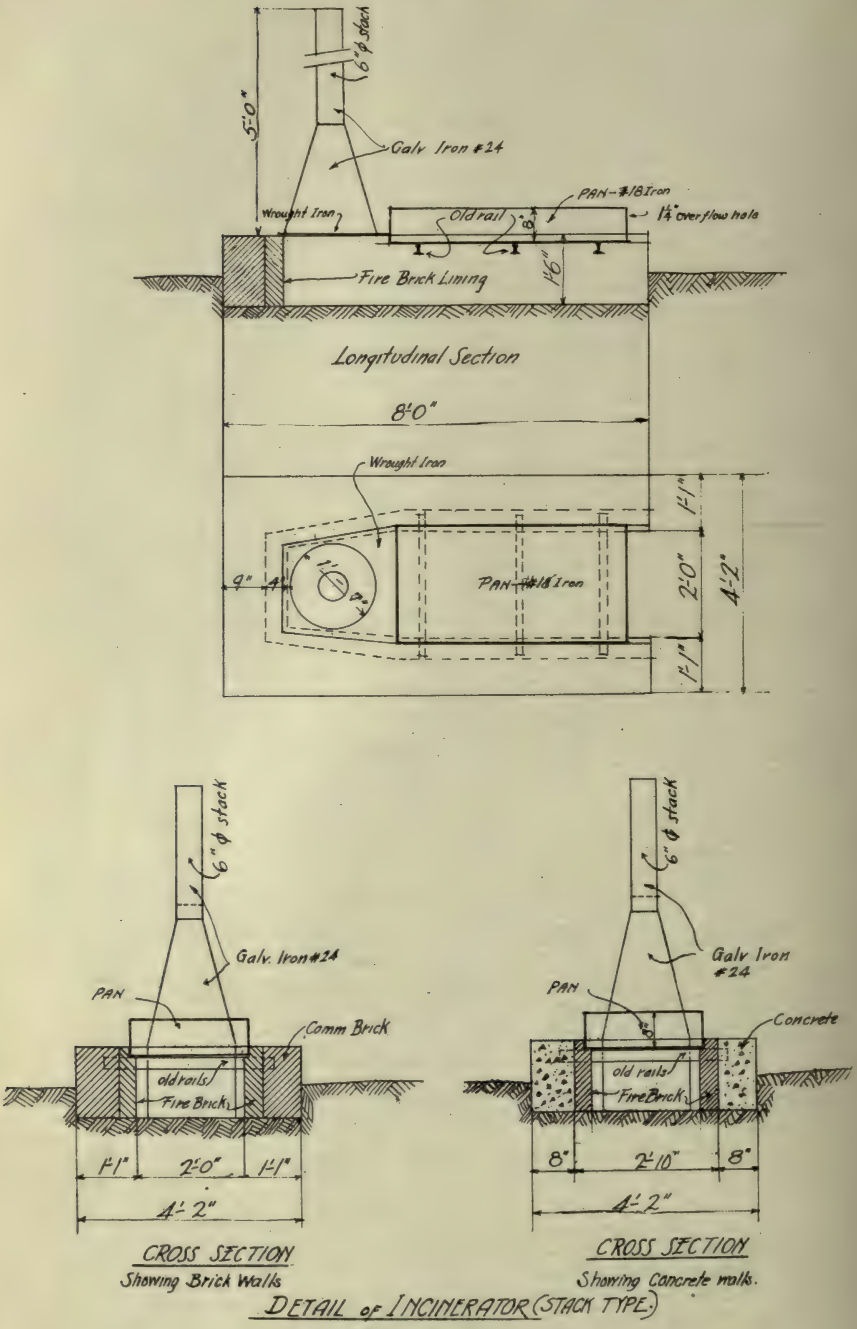
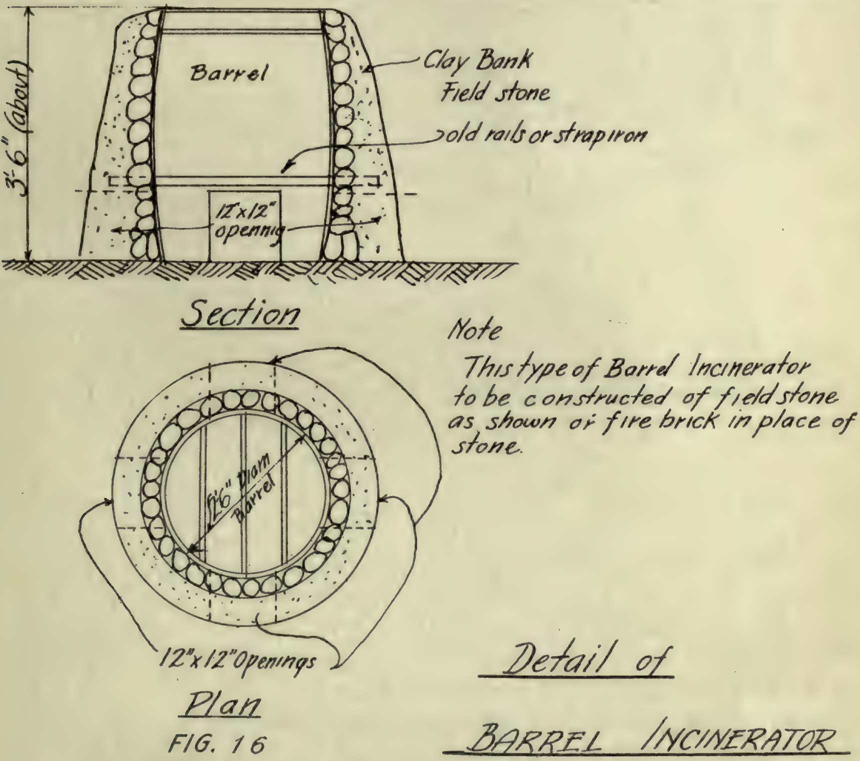


FIG. 15

A stack type incinerator for a camp of one hundred and fifty people. The pan shown is 8 inches in depth and is used to evaporate liquid slops, while the solid garbage is placed on top of the fuel. By treating the liquid thus separately, a great deal of fuel is saved.

The estimated cost of this incinerator as shown in Figure 15 is as follows:

	San Francisco	Sacramento	Fresno	Los Angeles
Brick type—				
Material	$21 00	$22 45	$23 90	$19 00
Labor	14 00	16 00	17 50	12 50
Total	$35 00	$38 45	$41 40	$31 50
Concrete type—				
Material	$21 75	$23 65	$24 60	$19 40
Labor	10 25	12 95	14 60	9 00
Total	$32 00	$36 60	$39 20	$28 40



Note
This type of Barrel Incinerator to be constructed of field stone as shown or fire brick in place of stone.

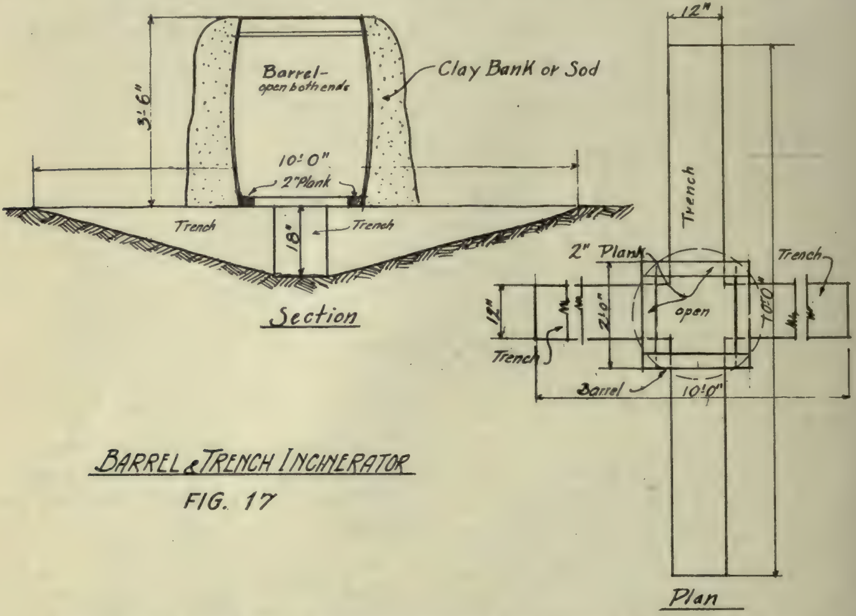
FIG. 16

A barrel type incinerator suitable for a camp of one hundred and twenty-five persons.

Figure 16 shows a barrel type incinerator suitable for a camp of 125 persons, which can be built at the following cost:

1 common flour or sugar barrel	$0 50
Placing clay	3 00
Old rails or scrap iron	50
Incidentals	2 00
Total	$6 00

Figure 17 shows a barrel and trench type incinerator suitable for a camp of 115 persons. This incinerator can be constructed in the following manner: Dig two trenches 10 feet long and 10 or 12 inches wide, bisecting each other. At the point of bisection, the trenches should be from 15 to 18 inches deep, gradually shallowing from this point to their origin. Over the place of bisection, place four boards to support an ordinary sugar or flour barrel. Around the barrel pile sods of earth and pack tightly up to the top of the barrel. If sods are not obtainable, use clay. Make a fire in the trench under the barrel and when the barrel is burned out, a hard cone of earth or clay is left.



BARREL & TRENCH INCINERATOR
FIG. 17

A barrel and trench type incinerator suitable for a camp of one hundred and fifteen persons.

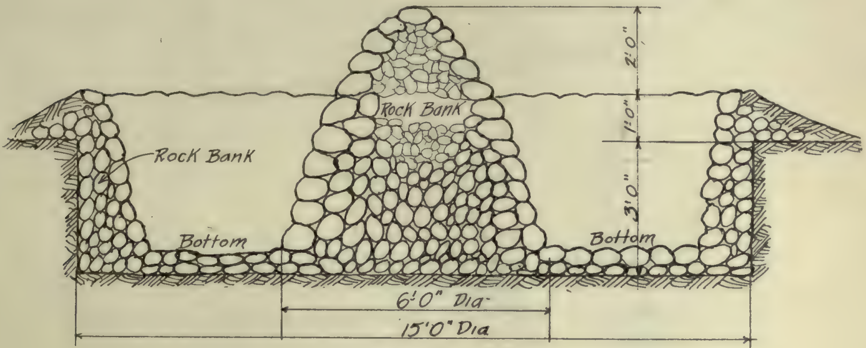
According to the direction of the wind, one trench opening near the cone is left open and the other three plugged with soil. Thus a flue is effected through the one opening and the top of the cone. The ashes should be raked out at the end of each day's use and a fresh fire started in the morning. Fuel and garbage are fed to the fire through the top of the cone.

The estimated cost of this incinerator is as follows:

1 yard excavation	$1 00
1 common sugar or flour barrel	50
Placing clay or sod	4 00
Incidentals	50
Total	$6 00

Figure 18 shows a rock pile incinerator which can be installed very cheaply if rock is available on the ground. This incinerator is suitable for a camp of about 2,500 persons. Construct as follows:

At some convenient point, dig a circular pit 3 feet in depth and 15 feet in diameter. Cover the bottom with loose stones to a depth of 14 to 16 inches. On this build a circular wall to a height of 1 foot above the original ground-line and pack tightly the excavated earth around the wall so as to provide a sloping approach, thereby preventing surface water from gaining access to the pit. Build a pyramid of large stones 4 or 5 feet high in the center to provide a central draft. The heat of the bottom stones evaporates the liquid slops while the solids are soon consumed as fuel for the fire. Precautions should be taken to empty the garbage into the crematory and not around it.



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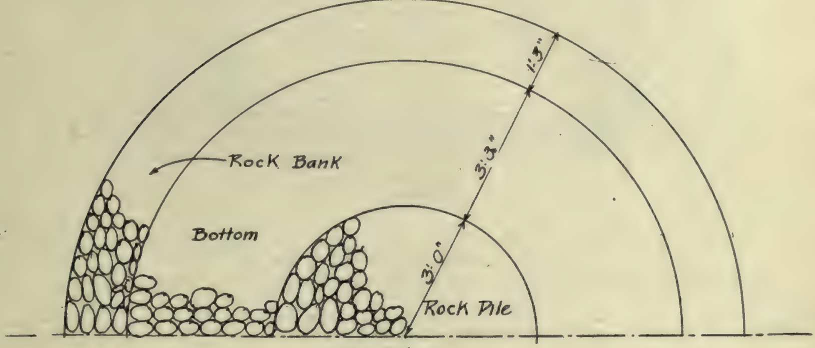


Half-Plan

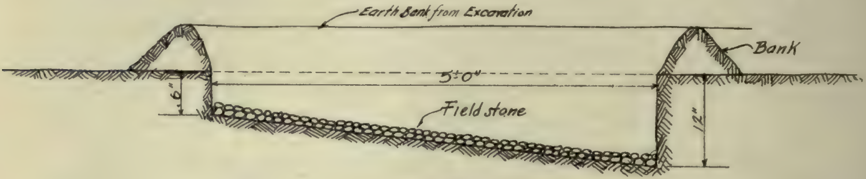
Rock Pile Crematory

FIG. 18

A rock pile incinerator which can be installed very cheaply if rock is available on the ground. This incinerator is suitable for a camp of about two thousand five hundred persons.

The estimated cost of this rock pile incinerator is as follows:

22 yards excavation	$22 00
Placing rock in place	15 00
Gathering and hauling stone	9 00
Cement	4 00
Total	$50 00



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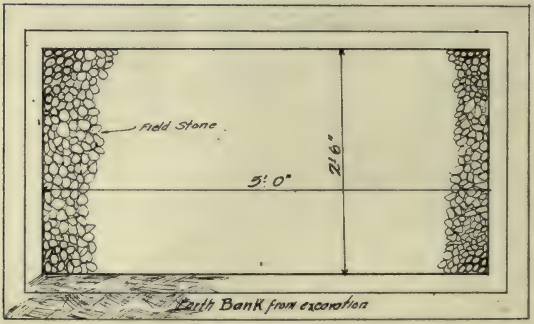


Plan

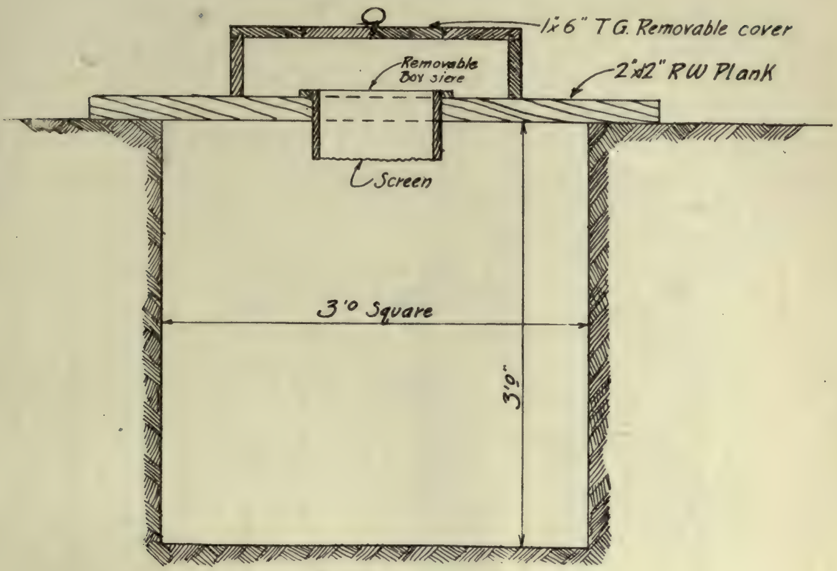
PIT INCINERATOR FIG. 19

A pit incinerator suitable for a camp of two hundred and fifty people.

Figure 19 shows a pit incinerator suitable for a camp of 250 people, which is estimated at the following cost:

Excavation	$1 00
Placing field stone	1 50
Incidentals	50
Total	$3 00

Construct as follows: Dig a pit 5 feet long, 2½ feet wide, 6 inches deep at one end and 12 inches deep at the other. Bank the excavated earth around the pit and fill it with stones on which to build the fire. When the stones have become heated, liquid refuse is poured into the pit at the shallow end where it gradually evaporates. Solid garbage is burned on the fire.



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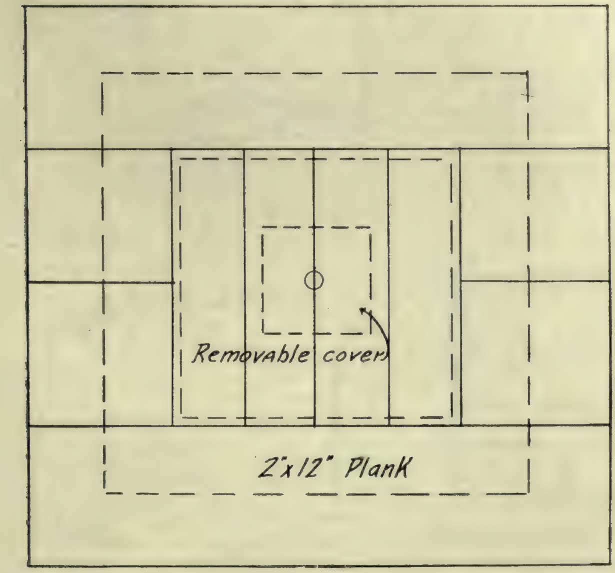


PLAN OF SLOP PIT

FIG. 20

A slop pit which can be used in camps of a few weeks' duration. All kitchen waste may be thrown into this pit.

Figure 20 shows a slop pit which can be used in camps of a few weeks' duration. All kitchen wastes may be thrown into this pit. To darken the pit and keep it free from flies, make a solid board top. Tamp it with earth and provide a detachable box sieve with cover, as shown in the figure. The pit should be 3 feet long, 3 feet wide and 3 feet deep when dug in clay. In more permeable soil, the dimensions may be somewhat reduced.

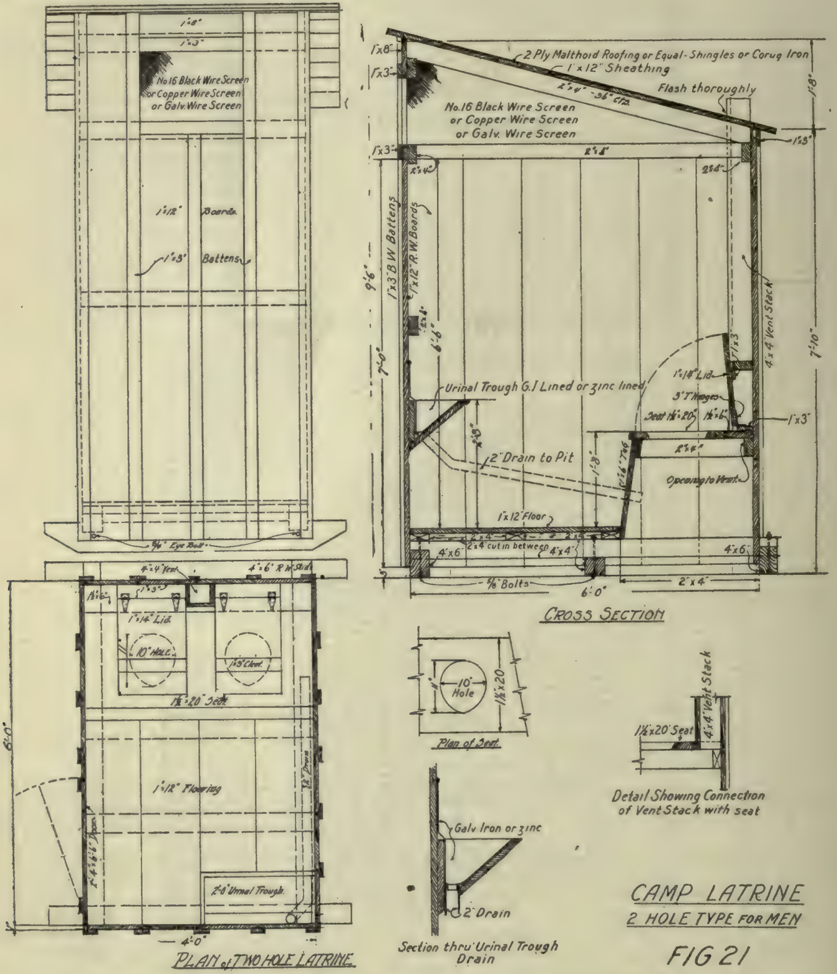


FIG 21

Men's two-hole toilet. The seat covers should be constructed so as to drop down over the hole as soon as the person rises, as shown in figure.

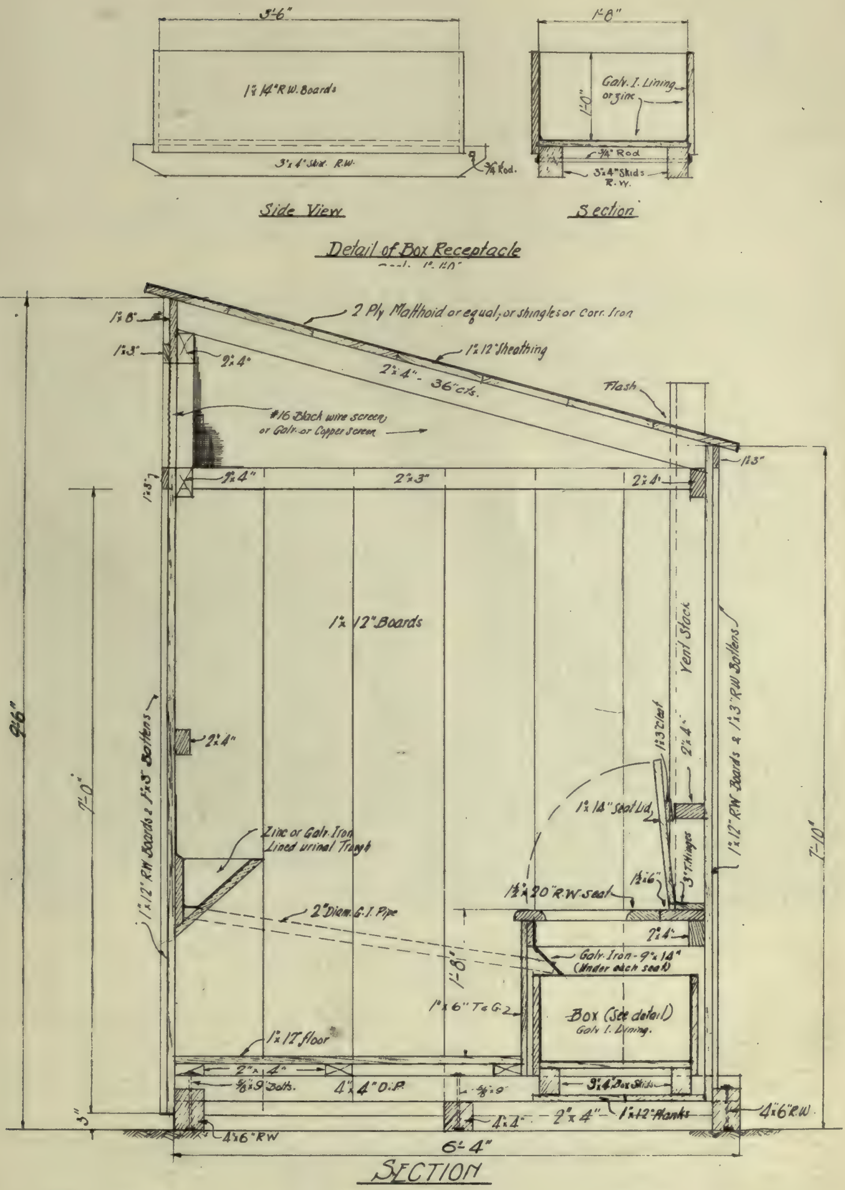


FIG. 22

— MENS LATRINE —

TWO HOLE-TYPE WITH BOX RECEPTACLE

A model fly-proof toilet with a box receptacle which can be hauled out into the field and the excreta used for fertilization.

VII.

Toilets.

1. There should be a sufficient number of toilets at convenient places, so as to afford one seat for every ten persons. In hop fields, fruit ranches and other places where men work in the field, there should be portable toilets, moved along conveniently near, affording at least one seat for 40 persons.

2. The toilets should be made fly-proof. All openings should be screened with No. 16 or 18 mesh wire screen, and all cracks should be battened. The bottom of the shelter should be banked up with earth where the frame touches the ground.

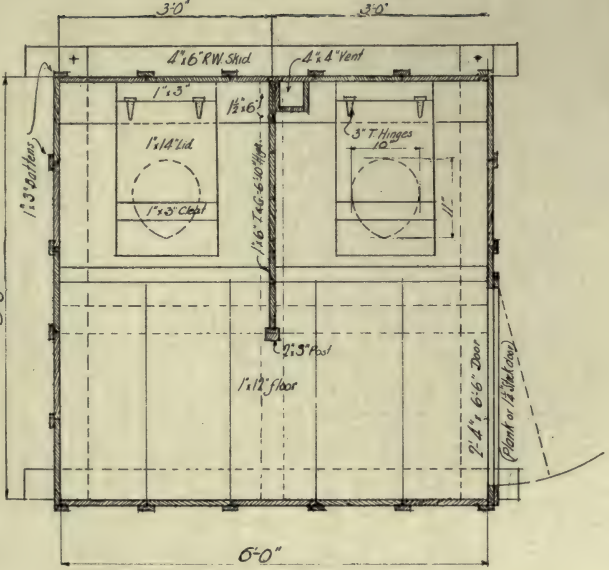
Toilets which violate every rule of sanitation. Actually in use in camps before the Commission began its inspection.

3. Doors should have spring hinges, coils or some other arrangement to close them automatically.

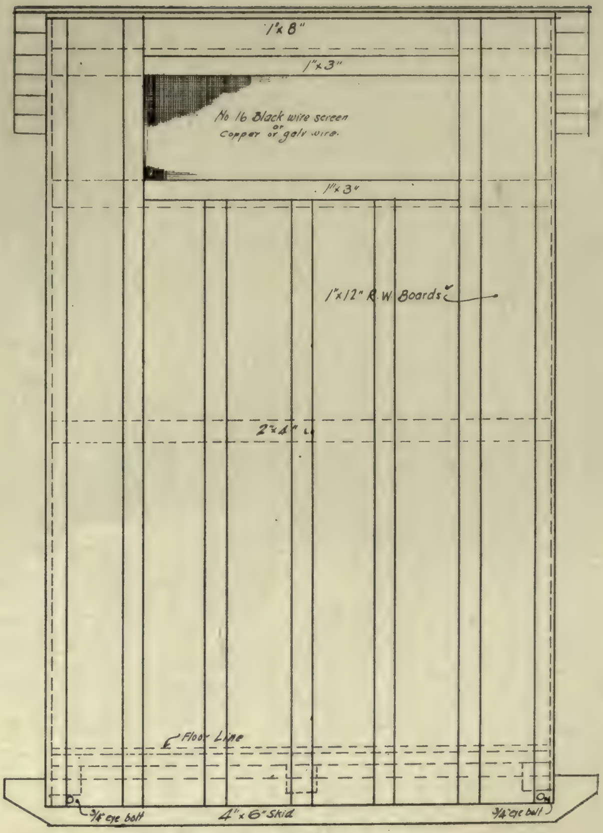
4. The seat covers should be constructed so as to drop down over the hole as soon as the person rises, as shown in Figure 21 (page 26).

5. The pit should be at least 4 feet in depth and when filled with excrement to within one foot of the surface, the building should be moved over a new hole, and the old hole filled with earth or thoroughly burned out with oil or oil-soaked straw.

6. It is recommended that the surface of the pit be covered daily



PLAN OF TWO HOLE LATRINE



·ELEVATION OF TWO HOLE LATRINE·

CAMP LATRINE FOR WOMEN

SINGLE ENTRANCE—2-HOLE

FIG. 25

A fly-proof toilet for women, with a single entrance and partition.

with one of the following substances: Crude oil, chloride of lime, or dry earth.

The crude oil is preferable for the following reasons:

(*a*) It is easily handled and the person who applies it runs no risk of contamination from the fecal matter.

(*b*) It is relatively small in bulk and easily transported.

(*c*) It keeps down bad odors and is repellant to flies.

(*d*) It does not fill the pit so quickly as the lime, thus prolonging the usefulness of the toilet.

7. A urinal trough, as shown in Figure 21, should be in each men's toilet, and this should be thoroughly washed out daily and the inside painted with crude oil.

8. If a box or other receptacle is used to receive the excreta, the contents should be emptied twice a week, the receptacle thoroughly washed and the inside painted with crude oil.

Figure 22 shows a model fly-proof toilet with a box receptacle which can be hauled out into the field and the excreta used for fertilization after proper treatment. (See page 27.)

9. In camps where women are employed, there should be a sufficient number of toilets for their use, marked "For Women Only." These should be at least 50 feet distant from the men's toilets.

10. Cleanliness and care in the use of all toilets should be insisted upon.

11. Paper should be provided in all toilets.

Figures 23 and 24 show two toilets which violate every rule of sanitation. These were actually in use in camps before the Commission began its inspection. (See page 28.)

Figure 25 shows a fly-proof toilet for women, with a single entrance and partitions. (See page 29.)

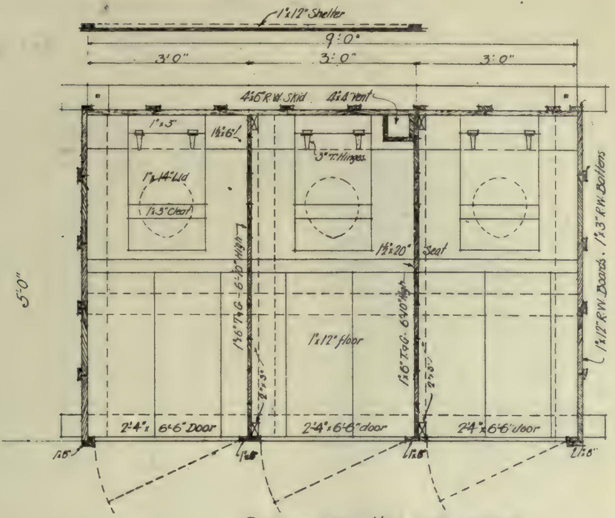
Figure 26 shows a fly-proof toilet for women with separate entrances.

Figure 27 shows an old unsanitary toilet and a new sanitary toilet, the latter built at Perkins, on the Horst hop ranch, under the supervision of the Commission. This five-hole toilet is similar in construction to the one shown in Figure 21. The cost was as follows:

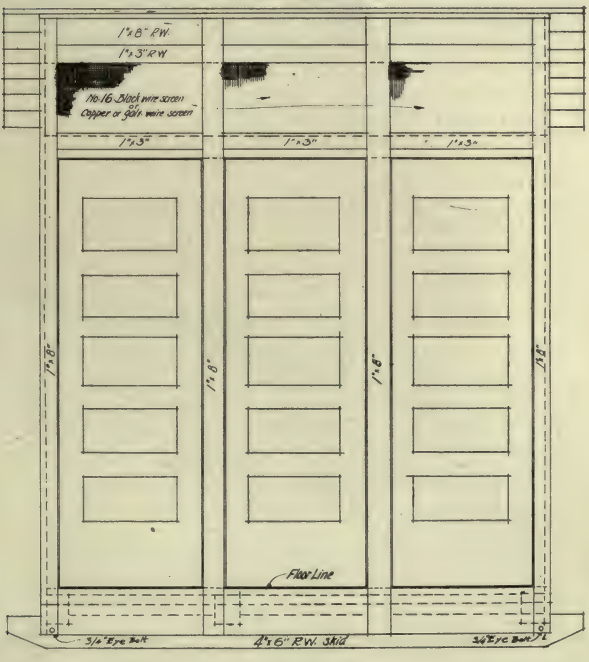
Lumber	$11 95
Hardware	81
Roofing paper	90
Labor	7 65
Total	$21 31

On the Durst Bros. hop ranch, at Wheatland, five-hole fly-proof toilets of the same construction were built, under the Commission's supervision, at the following cost per toilet:

Lumber	$12 24
Hardware	95
Roofing	90
Labor	8 00
Total	22 09



PLAN of THREE HOLE TYPE LATRINE



ELEVATION

(THREE HOLE TYPE)

CAMP LATRINE FOR WOMEN FIG. 26

A fly-proof toilet, with separate entrances, for women.

Figure 28 shows three of the ten five-hole toilets, built on the Horst hop ranch, Wheatland, under the Commission's supervision, at the following cost per building:

Lumber	$9 87
Hardware	81
Paper roofing	90
Labor	7 00
Total	$18 58

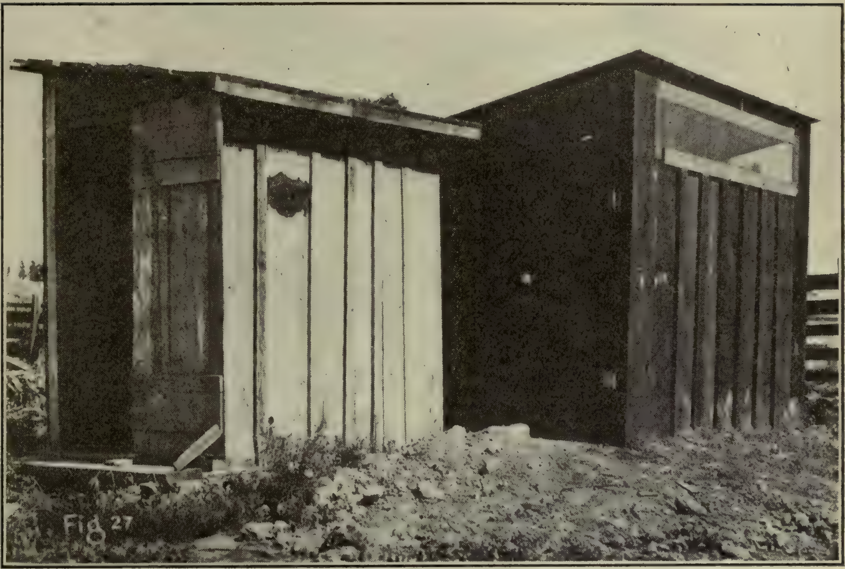
(The lumber for this work was purchased in a carload lot at San Francisco at a very low figure.)

The bill of material for men's two-hole toilet, as shown in Figure 21, is as follows:

2 pieces 4" x 6"— 5' 6" redwood skids.
1 piece 4" x 4"— 4' redwood center skid.
2 pieces 4" x 4"— 6' 6" Oregon pine girder.
3 pieces 2" x 4"— 4' Oregon pine joists.
4 pieces 2" x 4"— 1' 4" Oregon pine cut in between joists.
24 pieces 1" x 3"—10' redwood battens, etc.
22 pieces 1" x 12"—10' redwood siding, s. 1 s.
4 pieces 1" x 12"—14' Oregon pine floor and roof, s. 1 s.
4 pieces 2" x 4"—10' Oregon pine plates.
3 pieces 2" x 4"— 8' Oregon pine rafters.
1 piece 1½" x 20"— 4' redwood, clear, for seat.
1 piece 1½" x 6"— 4' redwood, clear, for seat.
1 door, 2' 4" x 6' 6", made of planks or may be stock door.
35 square feet 2-ply Malthoid, or equal, prepared roofing, or shingles or corrugated galvanized iron may be used.
5 feet 2" diameter galvanized iron pipe—urinal drain.
1 pair 6" strap hinges for door.
1 heavy spring coil (12" or 14").
2 pair 3" T hinges for seat covers.
6 ⅝" x 9' bolts, skids to girders.
4 ¾" x 6" eye bolts, 2" eye; one each end through skids.
2 pieces 1" x 6"— 6' redwood, s. 1 s., for vent stack.
1 piece 1" x 4"— 6' redwood, s. 1 s., for vent stack.
2 pieces 1" x 14"— 1' 8" Oregon pine, s. 1 s., for seat cover.
1 piece 1" x 8"— 4' above screen front.
15 square feet No. 16 black wire screen, or galvanized or copper wire screen.
2 pieces 1" x 6"— 8' tongue and groove, for seat front.
10 square feet zinc or galvanized iron urinal lining.

The estimated cost of this toilet is as follows:

	San Francisco	Sacramento	Fresno	Los Angeles
Material	$13 09	$16 89	$16 49	$14 93
Labor	8 90	10 40	11 20	7 00
Total	$21 99	$27 29	$27 69	$21 93



An old unsanitary toilet to the left, and a new sanitary toilet to the right, the latter built at Perkins, on the Horst hop ranch, under the supervision of the Commission. This five-hole toilet is similar in construction to the one shown in Figure 21 (page 26).

Three of the ten five-hole toilets, built on the Horst hop ranch, Wheatland, under the Commission's supervision.

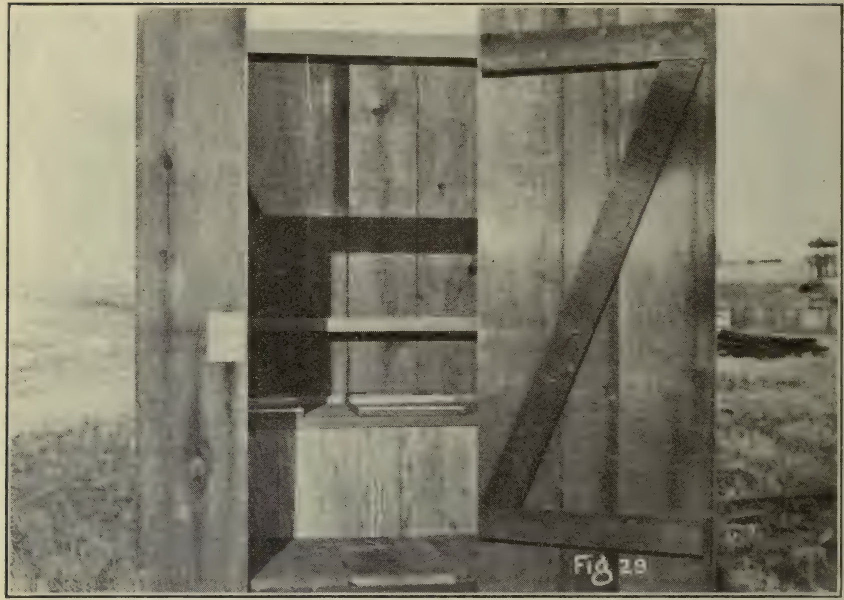


Fig 28

Picture of a portable toilet for field use, built under the Commission's supervision at the Horst ranch, Wheatland. This is suitable for use in hop fields, fruit ranches, etc.

The following is a bill of material for a two-hole toilet with box receptacle, as shown in Figure 22 (page 27):

2 pieces 4" x 6"— 4' redwood girder.
2 pieces 4" x 4"— 7' Oregon pine girder.
1 piece 4" x 4"— 4' redwood girder.
4 pieces 1" x 12"— 4' Oregon pine, s. 1 s., floor.
7 pieces 1" x 12"— 6' Oregon pine, s. 1 s., roof.
20 pieces 1" x 12"— 8' redwood for sides, s. 1 s.
2 pieces 1" x 12"—10' redwood for sides, s. 1 s.
4 pieces 1" x 3"—10' redwood battens.
18 pieces 1" x 3"— 8' redwood battens.
2 pieces 2" x 3"—12' Oregon pine plates.
4 pieces 2" x 4"—12' Oregon pine plates.
3 pieces 2" x 4"— 8' Oregon pine rafters.
2 pieces 1" x 6"— 6' redwood, s. 1 s., vent stack.
1 piece 1" x 4"— 6' redwood, s. 1 s., vent stack.
1 piece 1" x 8"— 4' redwood above screen front.
1 piece 1½" x 20"— 4' redwood, clear, for seat, and 2 pieces 1" x 6"—8' tongue and groove.
1 piece 1½" x 6"— 4' redwood for seat.
2 pieces 1" x 14"— 1' 8" Oregon pine, s. 1 s., for seat covers.
1 piece 1" x 14"—12' redwood for sides and ends of box receptacle.
1 piece 1" x 12"— 8' redwood for bottom of box receptacle.
2 pieces 3" x 4"— 4' redwood skids for box receptacle.
14 square feet galvanized iron or zinc lining for box receptacle.
1 door, 2' 4" x 6' 6", either plank or stock door.
35 square feet 2-ply Malthoid roofing, or equal; or shingles or corrugated galvanized iron.
1 pair 6" strap hinges for large door and 1 pair 4" strap hinges for small door.
1 heavy spring coil 12" or 14" for large door and 2 pair 3" T. hinges for seat lids.
6 ⅝" x 9" bolts for girders.
1 ¾" x 24" rod for box receptacle.
15 square feet screen, black wire, No. 16; or galvanized or copper screen.

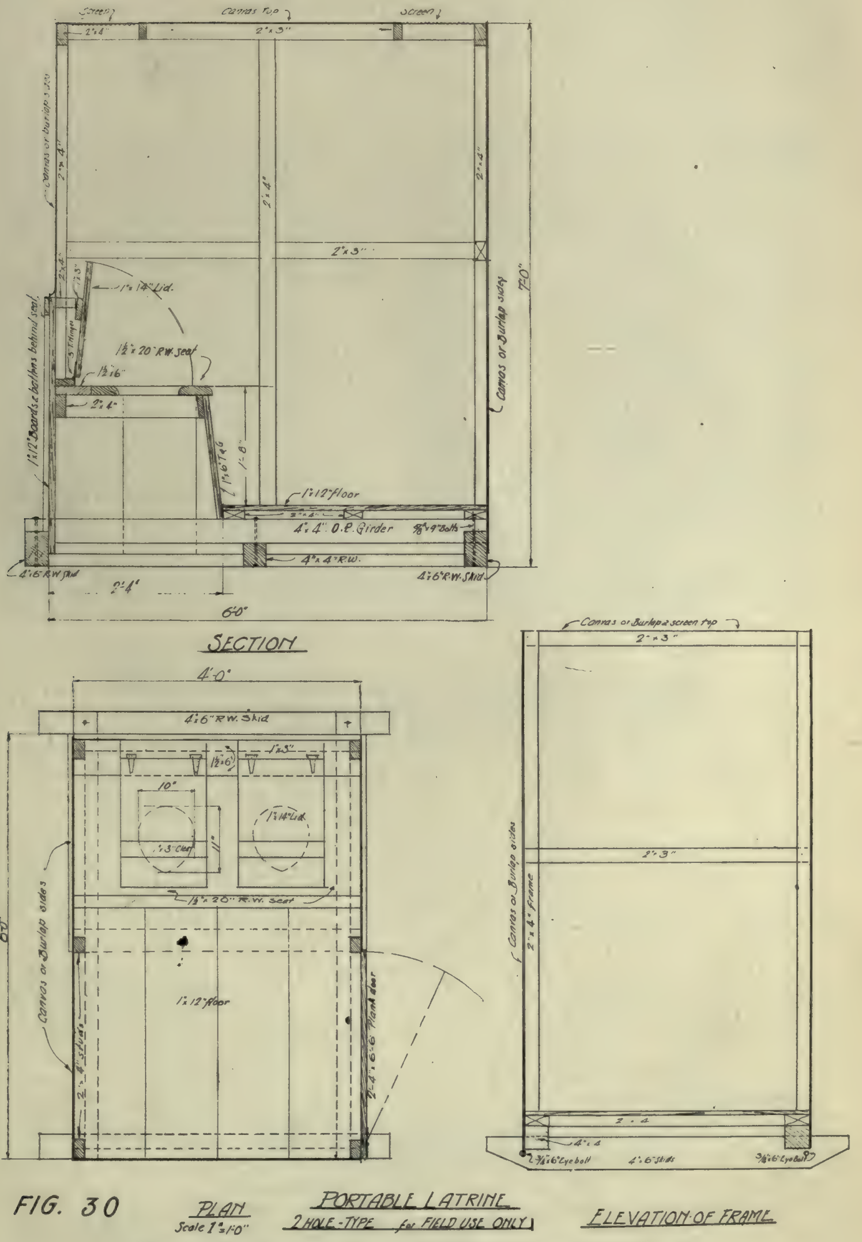


FIG. 30

Diagram of portable toilet shown in picture number 29.

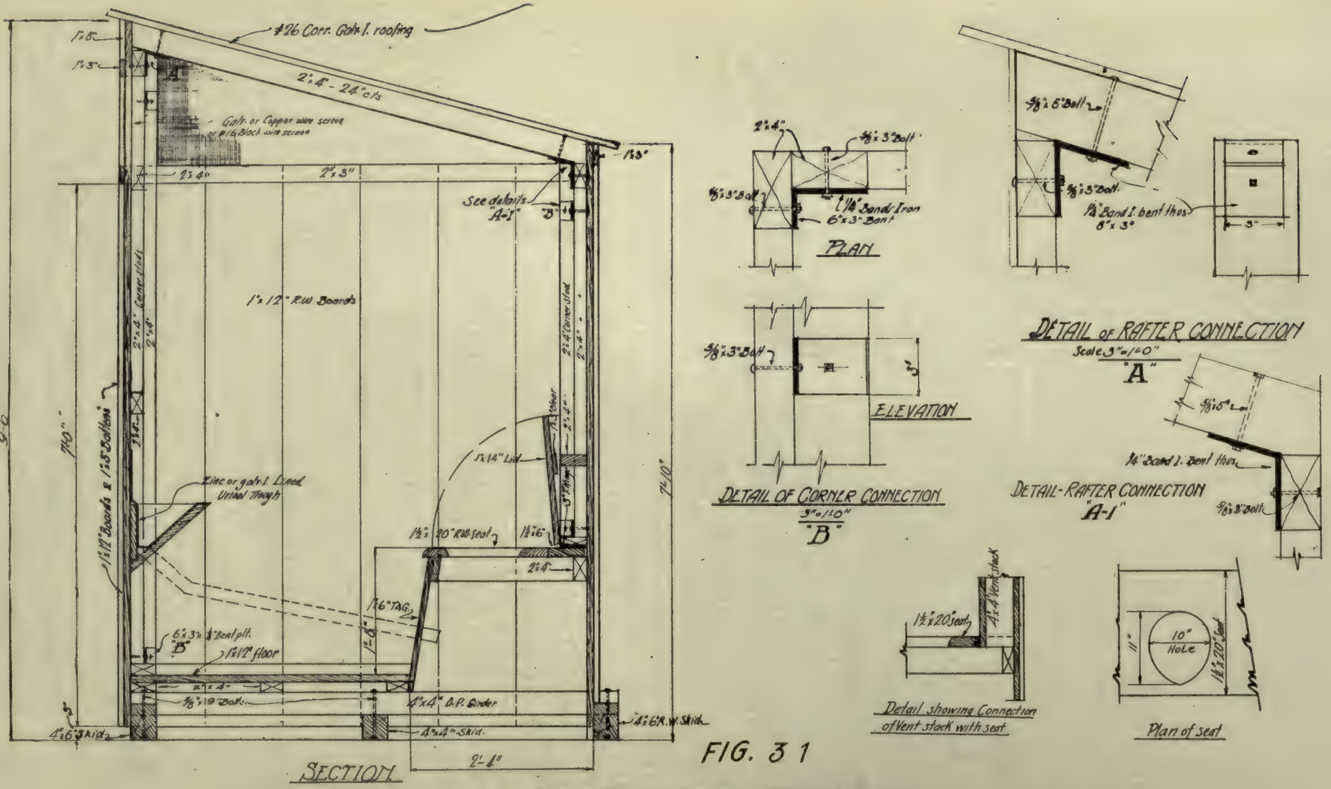


FIG. 31

KNOCK DOWN SYSTEM - MENS LATRINE

A fly-proof toilet, knock-down system, suitable for use in temporary camps. The corners marked "A" and "B" show the bolted connections, which can easily be taken apart and put up again.

The estimated cost of this toilet is as follows:

	San Francisco	Sacramento	Fresno	Los Angeles
Material	$15 49	$20 92	$21 45	$17 18
Labor	10 90	11 00	12 25	7 00
Total	$26 39	$31 92	$33 70	$24 18

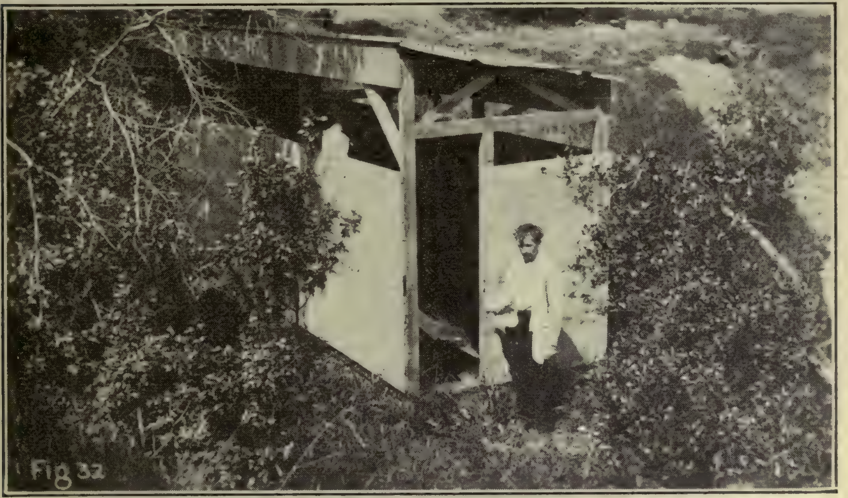
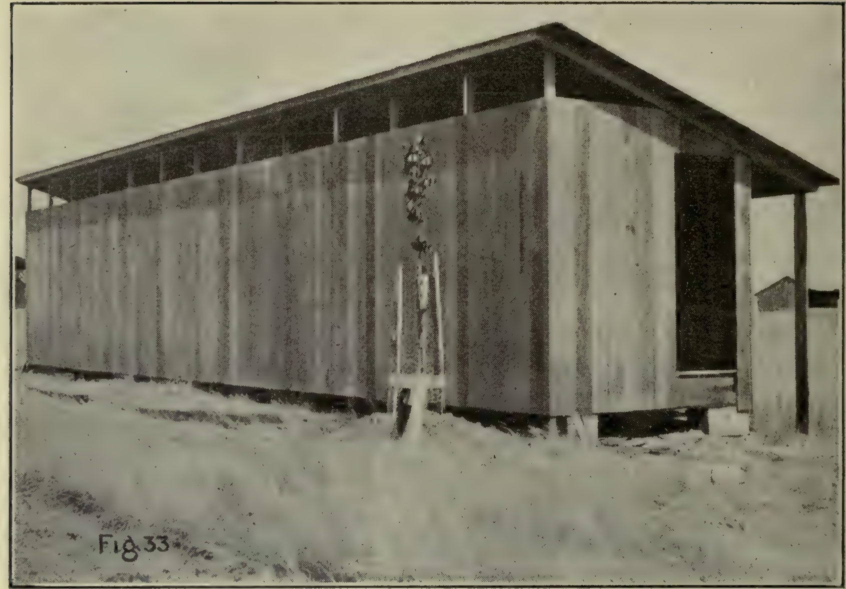


Fig 32

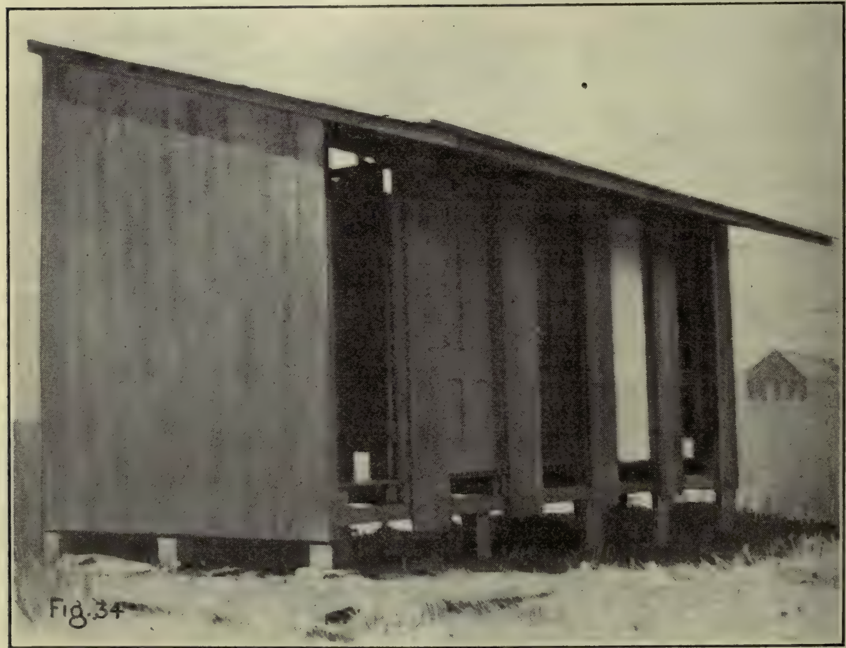
A men's six-shower bathhouse at the State Highway Camp, Shingle Springs, which was built under the supervision of the Commission.

The following is a bill of material for a women's toilet with single entrance, as shown in Figure 25 (page 29):

1 piece 4″ x 4″— 6′ redwood center skid.
1 piece 4″ x 6″—14′ redwood skid.
1 piece 4″ x 4″—20′ redwood girders.
2 pieces 2″ x 4″—12′ Oregon pine rafters.
6 pieces 2″ x 4″—12′ Oregon pine plates, etc.
3 pieces 2″ x 3′—12′ Oregon pine plates, etc.
2 pieces 1″ x 12″—10′ redwood, s. 1 s., siding, and 5 pieces 1″ x 12″—12′ redwood, for shelter fence.
14 pieces 1″ x 12″—16′ redwood, s. 1 s., siding.
16 pieces 1″ x 3″—16′ redwood battens, etc.
4 pieces 1″ x 3″—10′ redwood battens, etc.
8 pieces 1″ x 12′—12′ Oregon pine, s. 1 s., for floor and roof.
6 pieces 1″ x 6″—14′ Oregon pine tongue and groove, for partitions and seat front.
1 piece 2″ x 3″— 8′ Oregon pine, s. 4 s., post for partition and seat front.
1 piece 1″ x 8″— 6′ redwood over screen front.
1 piece 1½″ x 20″— 6′ redwood, clear, for seat, s. 1 s.
1 piece 1½″ x 6″— 6′ redwood, clear, for seat, s. 1 s.
2 pieces 1″ x 14″— 1′ 8″ redwood or Oregon pine seat cover, s. 1 s. (clear material).
1 piece 1″ x 6″—14′ redwood vent stack.
1 piece 1″ x 4″— 8′ redwood vent stack.
1 door 2′ 4″ x 6′ 6″ (plank or 1¼″ redwood stock door).
1 pair 6″ strap hinges for door.
1 heavy spring coil for door (12″ or 14″).
2 pair 3″ T hinges for seat covers.
4 ¾″ x 6″ eye bolts, 2″ eye; one on each end through skids.
6 ⅝″ x 9″ bolts, skids to girders.
48 square feet 2-ply Malthoid, or equal, roofing; or shingles or corrugated iron.
14 square feet wire screen, either No. 16 black wire, copper, or galvanized screen.



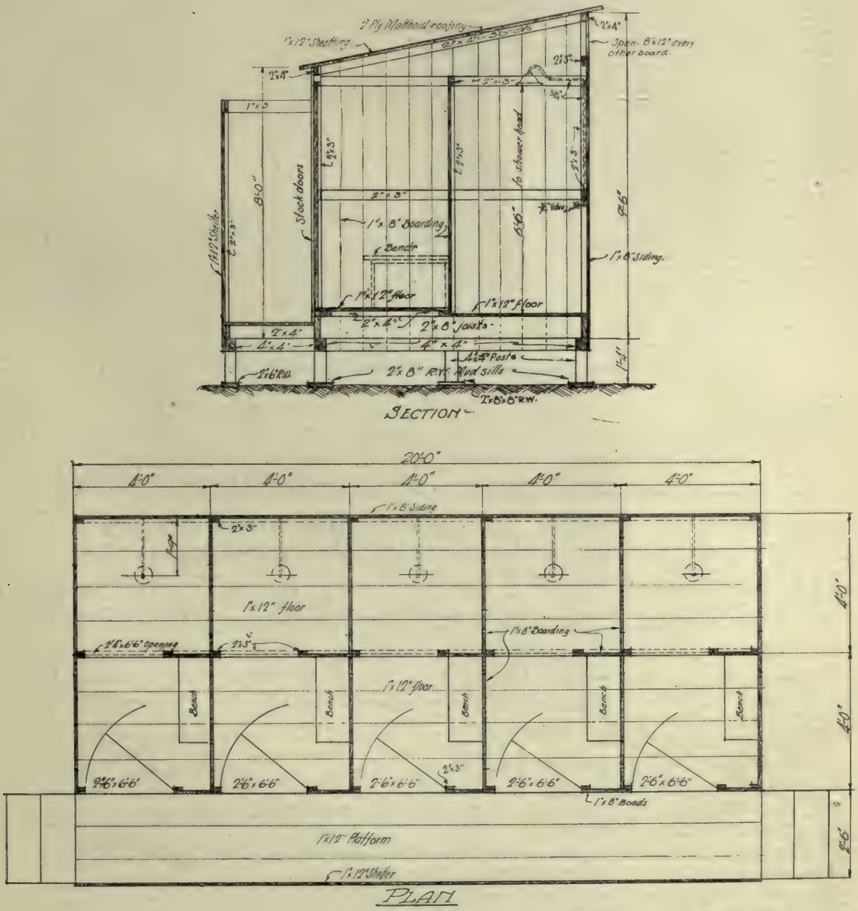
A model men's twelve-shower bathhouse, which was built under the supervision of the Commission on the Durst ranch, Wheatland.



Picture of a five-shower bathhouse for women, built under the supervision of the Commission on the Durst ranch, Wheatland.

The estimated cost of this women's toilet is as follows:

	San Francisco	Sacramento	Fresno	Los Angeles
Material	$12 12	$14 90	$15 10	$12 00
Labor	8 00	9 00	9 75	7 00
Total	$20 12	$23 90	$24 85	$19 00



WOMENS BATH HOUSE:
5 SHOWER TYPE

FIG. 35

Diagrams of bathhouse shown in picture number 34.

The following is a bill of material for a women's toilet with separate entrances, as shown in Figure 26 (page 31):

1 piece 4" x 6"—14' redwood skids.
1 piece 4" x 4"— 7' redwood center skid.
3 pieces 4" x 4"— 6' Oregon pine girders.
3 pieces 2" x 4"—12' Oregon pine rafters, plates, etc.
5 pieces 2" x 3"—12' Oregon pine plates, etc.
5 pieces 1" x 12"—14' Oregon pine, s. 1 s., for roof and floor.
3 pieces 1" x 12"—14' redwood for shelter.
10 pieces 1" x 12"—16' redwood, s. 1 s., for sides.
14 pieces 1" x 3"—16' redwood battens, etc.
7 pieces 1" x 6"—14' Oregon pine tongue and groove partitions.
1 piece 1" x 8"— 6' redwood over screen front.
3 pieces 1" x 8"—10' redwood between doors and at ends.
1 piece 1" x 6"—14' redwood vent stack.
1 piece 1" x 4"— 8' redwood vent stack.
1 piece 1½" x 6"— 6' redwood, for seat.
2 pieces 1" x 14"— 1' 8" redwood, seat cover.
2 doors, 2' 4" x 6' 6" plank, or 1¼" redwood stock doors.
2 doors, 2' 4" x 6' 6", plank or 1¼" redwood stock doors.
2 pair 6" strap hinges for doors.
2 heavy spring coils (12" or 18") for doors.
2 pair 3" T hinges for seat covers.
6 ⅝" x 9" bolts, skids to girders.
4 ¾" x 6" eye bolts, 2" eye; one each end through skids.
50 square feet 2-ply Malthoid, or equal, roofing; or shingles or corrugated iron may be used.
16 square feet wire screen, either copper, galvanized, or No. 16 black wire screen.

The estimated cost of this toilet is as follows:

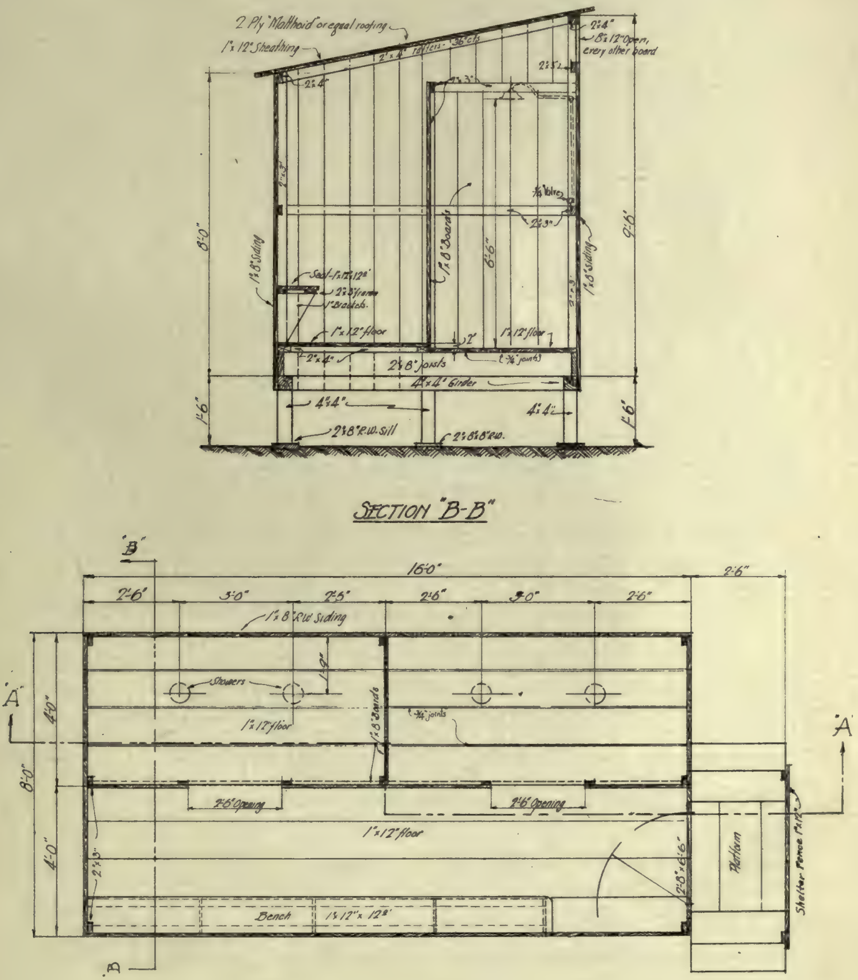
	San Francisco	Sacramento	Fresno	Los Angeles
Material	$15 59	$19 88	$20 62	$15 02
Labor	9 00	10 00	10 60	6 00
Total	$24 59	$29 88	$31 22	$21 02

Figures 29 and 30 show a picture and diagrams of a portable toilet for field use, built under the Commission's supervision at the Horst ranch, Wheatland. This is suitable for use in hop fields, fruit ranches, etc. The bill of material for the portable toilet, as shown in Figure 30, is as follows (pages 34 and 35):

2 pieces 4" x 6"— 5' redwood skid.
1 piece 4" x 4"— 4' redwood skid center.
2 pieces 4" x 4"—6' 6" Oregon pine girders.
6 pieces 2" x 4"— 7' Oregon pine studs.
6 pieces 2" x 4"— 8' Oregon pine plates, etc.
3 pieces 2" x 3"—12' Oregon pine plates.
2 pieces 1" x 6"—12' tongue and groove, for seat front.
6 pieces 1" x 12"— 8' redwood boards, s. 1 s., behind seat.
6 pieces 1" x 3"— 8' redwood battens behind seat.
1 piece 1½" x 20"— 4' redwood, clear, for seat, s. 1 s.
1 piece 1½" x 6"— 4' redwood for seat, s. 1 s.
2 pieces 1" x 14"— 1' 8" Oregon pine, s. 1 s., seat lid.
1 plank door 2' 4" x 6' 6".
1 pair 6" strap hinges for door.
1 heavy spring coil for door (12" or 18").
2 pair 3" T hinges for seat lid.
4 ¾" x 6" eye bolts, 2" eye; one each end.
6 ⅝" x 9" bolts; skids to girders.
10 square feet galvanized wire screen for top.
150 square feet canvas or burlap.

The estimated cost of this portable toilet is as follows:

	San Francisco	Sacramento	Fresno	Los Angeles
Material	$11 50	$11 80	$12 05	$10 80
Labor	7 00	8 00	8 50	6 00
Total	$18 50	$19 80	$20 55	$16 80



SECTION "B-B"

PLAN

MENS BATH HOUSE
4 SHOWER TYPE

FIG. 36

A men's four-shower bathhouse built under the supervision of the Commission at the Horst ranch, Wheatland.

Figure 31 shows a fly-proof toilet, knock-down system, suitable for use in temporary camps. The corners marked ''A'' and ''B'' show the bolted connections, which can easily be taken apart and put up again.

The bill of material for a two-hole toilet of this type is as follows:

2 pieces 4″ x 6″— 5′ 6″ redwood skids.
1 piece 4″ x 4″— 5′ 6″ redwood skid.
2 pieces 4″ x 4″— 6′ 6″ Oregon pine girders.
4 pieces 2″ x 4″— 8′ Oregon pine studs.
4 pieces 2″ x 4″— 9′ Oregon pine studs.
5 pieces 2″ x 4″— 8′ Oregon pine plates, etc.
3 pieces 2″ x 4″— 7′ Oregon pine rafters.
4 pieces 2″ x 3″— 6′ Oregon pine plates.
20 pieces 1″ x 12″— 8′ redwood, s. 1 s., sides and floor, and 2 pieces 10′.
2 pieces 1″ x 12″—10′ redwood, s. 1 s., sides and floor.
2 pieces 1″ x 12″—10′ redwood, s. 1 s., sides.
24 pieces 1″ x 3″— 8′ redwood battens and 4 pieces 10′.
2 pieces 1″ x 6″—12′ Oregon pine tongue and groove for seat front.
1 piece 1½″ x 20″— 4′ redwood, clear, for seat.
1 piece 1½″ x 6″— 4′ redwood for seat.
2 pieces 1″ x 6″— 7′ Oregon pine, s. 1 s., for stack.
1 piece 1″ x 4″— 7′ Oregon pine, s. 1 s., for stack.
2 pieces 1″ x 14″— 1′ 8″ Oregon pine for seat lids.
1 piece 1″ x 8″— 4′ redwood over screen front.
1 door, 2′ 4″ x 6′ 6″, made up of planks, or may be stock door.
3 6′ sheets corrugated galvanized iron roofing.
1 pair 6″ strap hinges for door.
1 heavy spring coil (12″ or 14″).
2 pair 3″ T hinges for seat covers.
4 ⅝″ x 9″ bolts; skids to girder.
4 ¾″ x 6″ eye bolts, 2″ eye; one each end through skid.
8 corner connections marked "B" with 16 ⅝″ x 3″ bolts.
6 rafter connections marked "A" and "A1" with 6 ⅝″ x 3″ bolts.

The estimated cost of a two-hole toilet, knock-down system, as shown in Figure 31 (page 36), is as follows:

	San Francisco	Sacramento	Fresno	Los Angeles
Material	$20 60	$23 10	$23 90	$20 15
Labor	8 00	8 50	9 00	6 00
Total	$28 60	$31 60	$32 90	$26 15

VIII.

Bathing Facilities.

1. There should be facilities for bathing: tubs, showers or a shelter built on a stream, where persons may bathe in privacy.

2. If showers or tubs are used, there should be a sufficient number to provide one for every twenty persons.

Showers are far preferable to tubs, as they are cheaper to install and are more sanitary. Furthermore, a shower can accommodate more bathers.

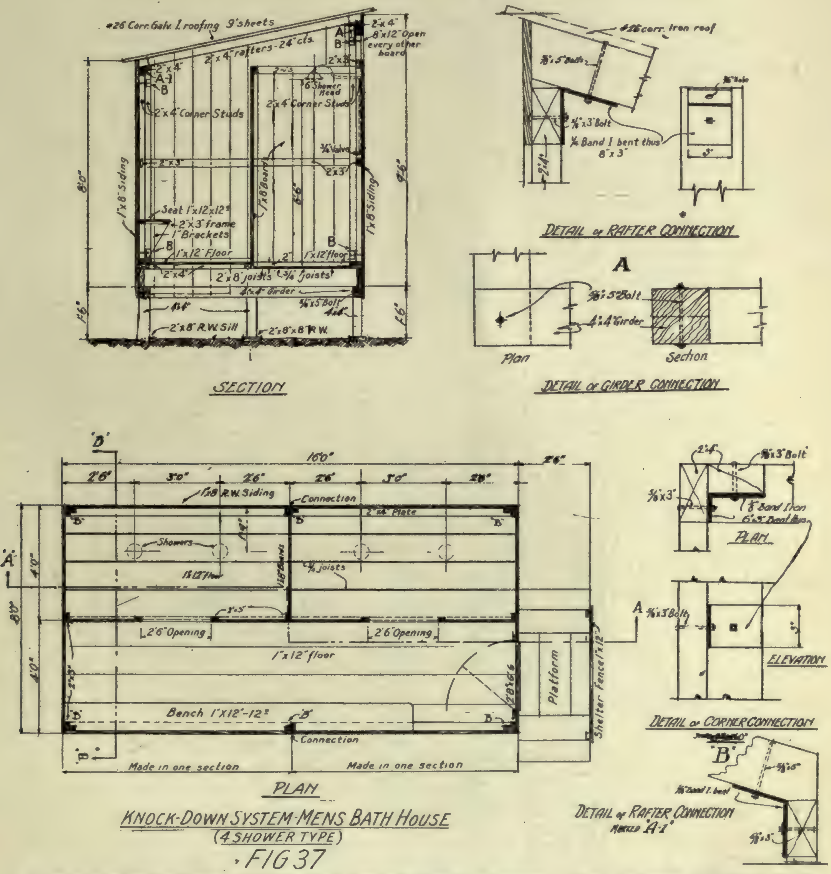
3. In camps where women are employed, separate bathing facilities should be provided and marked, ''For Women Only.''

4. In winter camps warm water should be provided for bathing purposes.

5. In every case the places for bathing should be conveniently near the sleeping quarters.

6. The waste water from baths should be properly drained away so as to avoid the formation of stagnant pools.

7. All tubs and bathhouses should be kept clean.

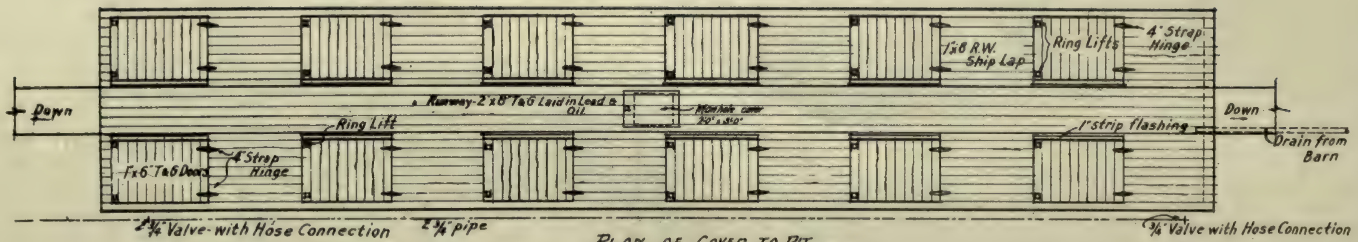


KNOCK-DOWN SYSTEM-MENS BATH HOUSE
(4 SHOWER TYPE)
FIG 37

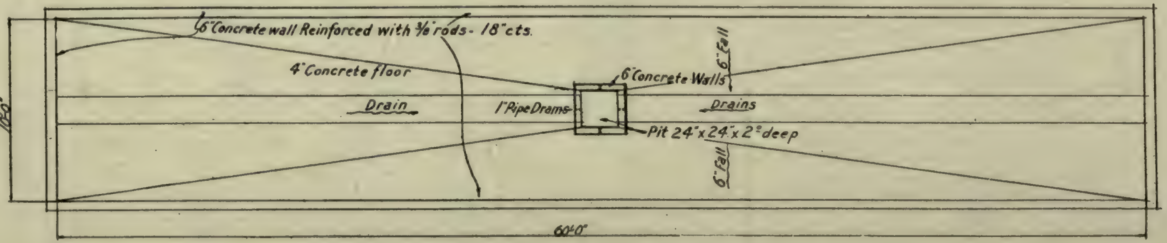
A model four-shower bathhouse, knock-down system. The corners marked "A" and "B" show the bolted connection, which can easily be taken apart and put together again.

Figure 32 shows a men's six-shower bathhouse at the State Highway Camp, Shingle Springs, which was built under the supervision of the Commission. The cost of this bathhouse, including a wooden tank of 1,080 gallons capacity, was as follows:

Material	$50 89
Labor	32 15
Total	$83 04



PLAN OF COVER TO PIT



PLAN OF CONCRETE PIT

FIG 38

A concrete fly-proof composting pit. The capacity of this pit is 2,700 cubic feet, and will store the offal of ten horses for a period of six months.

Figure 33 shows a men's model twelve-shower bathhouse, which was built under the supervision of the Commission on the Durst ranch, Wheatland, at the following cost (page 38):

Lumber	$100 00
Pipe and fittings	31 74
Labor (carpentry)	24 00
Labor (plumbing)	12 00
Total	$167 74

Figures 34 and 35 show the picture and diagram of a five-shower bathhouse for women, also built under the supervision of the Commission on the Durst ranch, Wheatland. The following is the cost of same:

Lumber	$55 00
Pipe and fittings	13 22
Labor (carpentry)	17 40
Labor (plumbing)	6 00
Total	$91 62

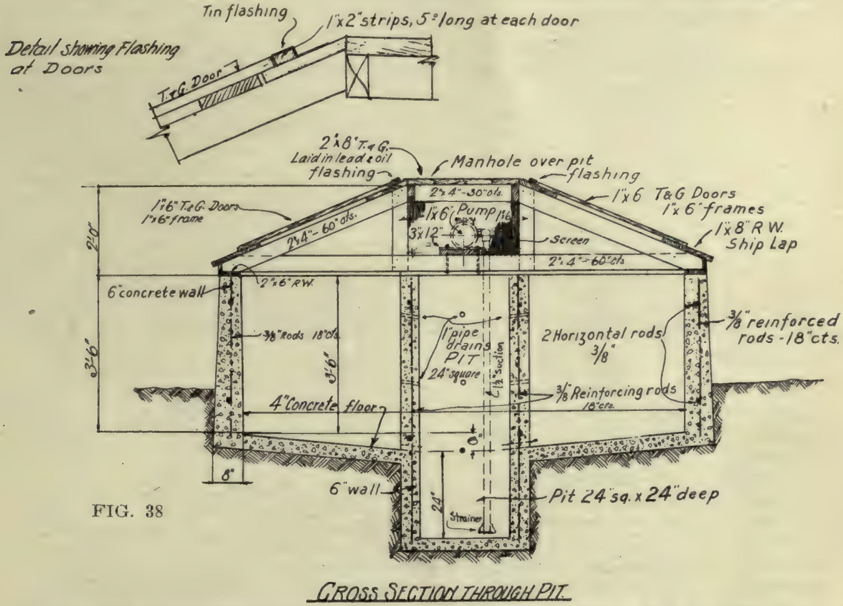


FIG. 38

A concrete fly-proof composting pit. The capacity of this pit is 2,700 cubic feet, and will store the offal of ten horses for a period of six months.

Figure 36 shows a four-shower men's bathhouse built under the supervision of the Commission at the Horst ranch, Wheatland, at the following cost (page 41):

Lumber	$24 50
Pipe and fittings	10 58
Labor (carpentry)	13 20
Labor (plumbing)	5 00
Total	$53 28

The following is the bill of material for a women's five-shower bathhouse, as shown in Figure 35 (page 39):

12 pieces 1″ x 12″—20′ Oregon pine, s. 1 s., floor.
20 pieces 1″ x 12″—12′ Oregon pine, s. 1 s., roof.
10 pieces 1″ x 12″—14′ redwood shelter.
5 pieces 1″ x 12″— 2′ 6″ for bench.
4 pieces 2″ x 8″—12′ redwood mud sill.
2 pieces 2″ x 6″—10′ redwood mud sill.
10 pieces 4″ x 4″—10′ Oregon pine underpinning.
4 pieces 2″ x 8″—10′ Oregon pine blocking between joists.
7 pieces 2″ x 4″—16′ Oregon pine joists, plates, etc.
8 pieces 2″ x 4″— 8′ Oregon pine rafters.
17 pieces 2″ x 3″—20′ Oregon pine studs, plates, etc.
10 pieces 1″ x 3″—10′ Oregon pine nailing strips.
40 pieces 1″ x 8″—10′ redwood siding, ship-lap.
34 pieces 1″ x 8″— 8′ redwood siding, ship-lap.
32 pieces 1″ x 8″—14′ redwood, s. 2 s., shower partitions.
6 pieces 2″ x 8″—16′ Oregon pine joists.
200 square feet 2-ply Malthoid roofing, or equal.
5 6″ shower heads, ¾″ connections; 5 ¾″ globe valves.
4 ¾″ tees; 7 ¾″ elbows; 5 pair 6″ strap hinges.
65 feet ¾″ galvanized iron pipe; 4 ¾″ caps.
5 stock doors, 2′ 6″ x 6′ 6″ x 1¼″.

The estimated cost of this bathhouse is as follows:

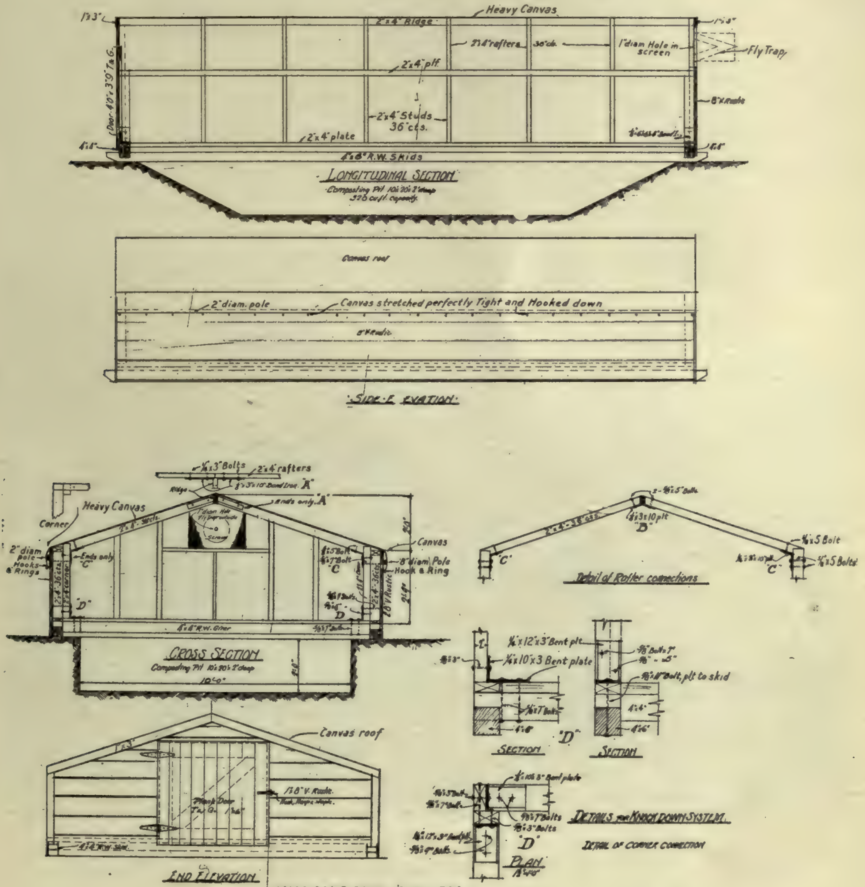
	San Francisco	Sacramento	Fresno	Los Angeles
Material	$72 82	$80 50	$82 10	$70 95
Labor	36 00	38 00	40 00	30 00
Total	$108 82	$118 50	$122 10	$100 95

The following is the bill of material for the four-shower men's bathhouse shown in Figure 36 (page 41):

3 pieces 2″ x 8″—16′ redwood mud sills.
1 piece 4″ x 4″—12′ redwood posts.
3 pieces 4″ x 4″—16′ Oregon pine girders.
19 pieces 2″ x 3″—16′ Oregon pine plates, etc.
7 pieces 2″ x 8″—16′ Oregon pine joists.
8 pieces 1″ x 12″—16′ Oregon pine for flooring, s. 1 s.
5 pieces 2″ x 4″—20′ Oregon pine for rafters, joists, etc.
10 pieces 1″ x 12″—18′ No. 2 Oregon pine, s. 1 s., roof.
14 pieces 1″ x 8″—18′ No. 2 Oregon pine sheathing, s. 2 s.
52 pieces 1″ x 8″—10′ redwood ship-lap siding, s. 1 s.
30 pieces 1″ x 8″— 9′ redwood ship-lap siding.
1 piece 2″ x 12″—12′ Oregon pine for steps.
1 piece 1″ x 12″—12′ Oregon pine, s. 1 s., bench.
2 pieces 2″ x 3″—12′ Oregon pine bench frame.
5 pieces 1″ x 12″— 8′ redwood for shelter.
1 pair 6″ strap hinges.
4 6″ shower heads, ¾″ connections.
4 ¾″ globe valves.
3 ¾″ tees; 6 ¾″ elbows; 2 ¾″ caps.
50 feet ¾″ galvanized iron pipe.
144 square feet 2-ply Malthoid roofing, or equal; or shingles or corrugated galvanized iron may be used.
1 stock door, 2′ 8″ x 6′ 6″ x 1¼″.

The estimated cost of this bathhouse is as follows:

	San Francisco	Sacramento	Fresno	Los Angeles
Material	$48 98	$59 24	$60 26	$47 96
Labor	28 00	30 50	33 00	26 00
Total	$76 98	$89 74	$93 26	$73 96



KNOCK DOWN SYSTEM
COMPOSTING PIT FOR TEMPORARY CAMP

FIG 39

A composting pit, knock-down system, for temporary camps. This pit has a capacity of 320 cubic feet and will store the offal of ten horses for a period of twenty-one days.

Figure 37 shows a model four-shower bathhouse, knock-down system. The corners marked "A" and "B" show the bolted connections which can easily be taken apart and put together again. (See page 43.)

The bill of material for this bathhouse is as follows:

3 pieces 2″ x 8″—16′ redwood mud sills.
1 piece 4″ x 4″—12′ redwood posts.
3 pieces 4″ x 4″—16′ Oregon pine girders.
12 pieces 2″ x 3″—16′ Oregon pine plates, etc.
7 pieces 2″ x 8″—16′ Oregon pine joists—solid bridging between joists at ends.
8 pieces 1″ x 12″—16′ Oregon pine for flooring, s. 1 s.
12 pieces 2″ x 4″— 8′ Oregon pine for studs.
14 pieces 2″ x 4″—16′ Oregon pine rafters, joists, plates, etc.
14 pieces 1″ x 8″—16′ Oregon pine sheathing (for shower partitions).
52 pieces 1″ x 8″—10′ redwood ship-lap siding, s. 1 s.
30 pieces 1″ x 8″— 9′ redwood ship-lap siding, s. 1 s.
1 piece 2″ x 12″—12′ Oregon pine for steps.
1 piece 1″ x 12″—12′ Oregon pine bench.
5 pieces 1″ x 12″— 8′ redwood for shelter.
1 pair 6″ strap hinges for door.
4 6″ shower heads, ¾″ connections.
4 ¾″ globe valves.
3 ¾″ tees; 6 ¾″ elbows; 2 ¾″ caps.
50 feet ¾″ galvanized iron pipe.
1 stock door 2′ 8″ x 6′ 6″ x 1¼″.
4 ⅝″ x 5″ bolts, girder connections.
12 corner connections marked "B," with 24 ⅝″ x 3″ bolts.
18 rafter connections marked "A" and "A-1," with 16 ⅝″ x 3″ bolts and 16 ⅝″ x 5″ bolts.
9 sheets No. 26 corrugated galvanized iron roofing, 9′ long.

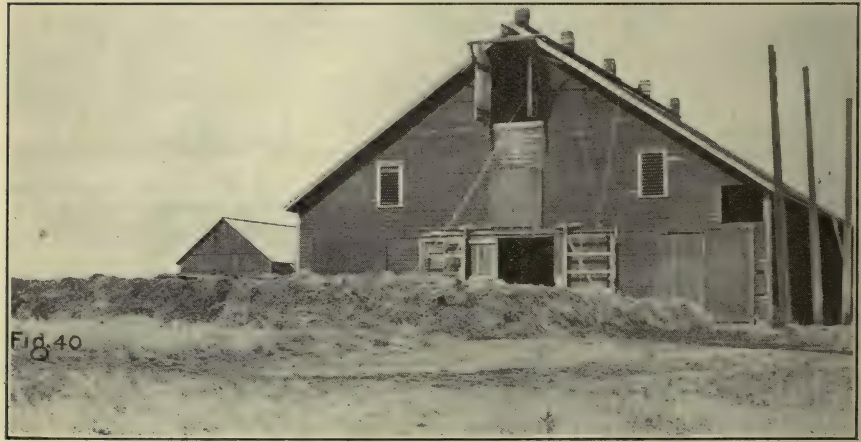


Fig. 40

A pile of manure 50 feet long, 45 feet wide and 4 feet high. This manure is near the mess, cook and bunk houses.

The estimated cost of this bathhouse is as follows:

	San Francisco	Sacramento	Fresno	Los Angeles
Material	$68 47	$76 71	$72 26	$67 62
Labor	30 00	33 00	35 00	27 00
Total	$98 47	$109 71	$110 26	$94 62

IX.

Towels.

1. Roller towels, if used, should be changed frequently.

2. The use of individual towels, rather than the common towel, is strongly urged.

3. Paper towels are suitable and can be furnished at small expense.

X.

Flies and Manure.

1. The open manure pile should be eliminated.

2. Stables and stalls near camps should be kept thoroughly clean.

3. For permanent camps, cement floors with proper drainage for the stables are recommended. This eliminates the cracks common to board floors in which the offal collects and flies breed.

4. Manure should be disposed of daily, either by hauling it into the field and spreading it in thin layers on the land, or by placing it into a fly-proof composting pit, or by burning.

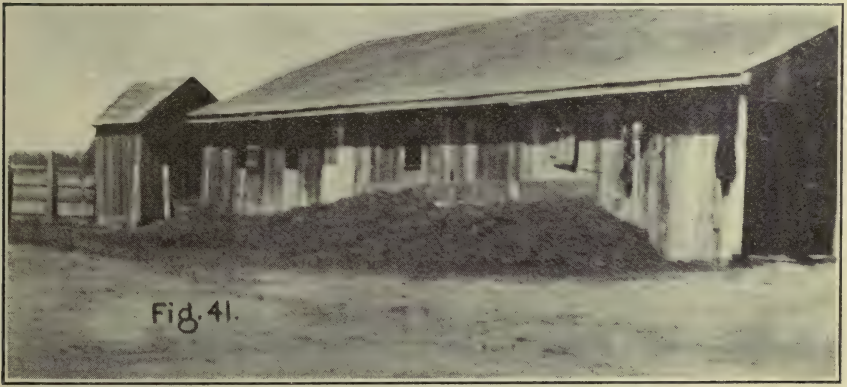


Fig. 41.

A pile of manure stacked up against the side of a barn, which is about 50 feet from the kitchen, mess-house and sleeping quarters. This pile of manure is not only a fly-breeding place, but may cause the side of the barn to cave in, or set fire to it.

Figure 38 shows a concrete fly-proof composting pit. The capacity of this pit is 2,700 cubic feet, and will store the offal of ten horses for a period of six months. The average horse produces 1½ cubic feet of manure per day, including bedding.

This composting pit will enable the farmer to save a great proportion of his manure from going to waste. A sump is provided to take care of the urine, which is the most valuable part of the excreta of animals. Urine is rich in nitrogen and in potash, which are successfully preserved with the dung in this pit. By means of a pump, as shown in Figure 38, the manure can be frequently moistened with the urine. Water should also be run into the pit to prevent the slow burning inside the pile, which destroys all of the fertilizing salts.

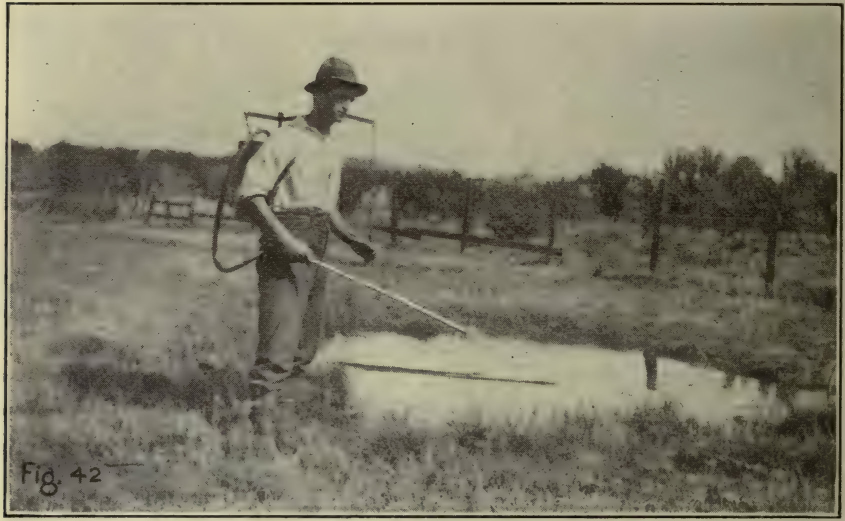


Fig. 42

A knapsack spray, five-gallon capacity, which is recommended for applying the oil on pools of stagnant water.

The bill of material for this composting pit is as follows:

308 lineal feet ⅜" twisted steel for horizontal reinforcing.
350 lineal feet ⅜" twisted steel for vertical reinforcing.
65 lineal feet ⅜" twisted steel for vertical reinforcing in pit.

For concrete forms—
168 pieces 1" x 6"—10' Oregon pine, s. 1 s.
90 pieces 2" x 4"—12' Oregon pine.

Concrete—
Floor—210 cubic feet=13 barrels cement, 4 cubic yards sand, 7½ cubic yards gravel.
Walls—400 cubic feet=23 barrels cement, 7 cubic yards sand, 14 cubic yards rock.
4 pieces 2" x 6"—20' redwood plates and 1 piece 3" x 12"—6' pump foundation.
3 pieces 2" x 6"—24' redwood plates.
13 pieces 2" x 4"—12' Oregon pine truss.
13 pieces 2" x 4"—10' Oregon pine truss.
2 pieces 2" x 4"—14' Oregon pine truss.
3 pieces 1" x 6"—10' Oregon pine truss.
2 pieces 2" x 4"—20' Oregon pine runway.
4 pieces 2" x 4"—22' Oregon pine runway.
12 pieces 2" x 4"—10' Oregon pine rafters.
15 pieces 2" x 8"—20' Oregon pine tongue and groove floor of runway.
30 pieces 1" x 8"—10' redwood ship-lap top covering.
48 pieces 1" x 6"—12' Oregon pine tongue and groove for doors.
12 pieces 1" x 2"— 5' Oregon pine strips.
7 pieces 1" x 6"—14' Oregon pine for door frames.
12 pieces 1" x 6"—10' Oregon pine for door frames.
12 pairs 4" strap hinges and 24 ring lifts.
12 pieces 1" pipe 6" long for weep holes for pit.

The cost of this fly-proof composting pit is as follows:

	San Francisco	Sacramento	Fresno	Los Angeles
Material	$245 60	$257 80	$256 10	$236 25
Labor	140 00	155 00	158 00	125 00
Total	$385 60	$412 80	$414 10	$361 25

Figure 39 shows a composting pit, knock-down system, for temporary camps. This pit has a capacity of 320 cubic feet and will store the offall of ten horses for a period of twenty-one days.

The bill of material is as follows:

2 pieces 4″ x 6″—22′ redwood skids.
2 pieces 4″ x 4″—12′ redwood girders.
2 pieces 2″ x 4″—12′ Oregon pine plates.
2 pieces 2″ x 4″—22′ Oregon pine plates.
16 pieces 2″ x 4″— 2′ 6″ Oregon pine studs (sides).
8 pieces 2″ x 4″— 3′ Oregon pine studs (ends).
4 pieces 2″ x 4″— 4′ Oregon pine studs (ends).
16 pieces 2″ x 4″— 7′ Oregon pine rafters.
1 piece 2″ x 4″—22′ Oregon pine ridge.
10 pieces 1″ x 8″—22′ pine rustic sides.
12 pieces 1″ x 8″— 4′ pine rustic ends.
2 pieces 1″ x 8″—12′ pine rustic ends.
2 pieces 1″ x 8″—10′ pine rustic ends.
2 pieces 1″ x 8″— 8′ pine rustic ends.
2 pieces 1″ x 8″— 5′ pine rustic ends.
4 pieces 1″ x 6″—12′ Oregon pine, s. 2 s., tongue and groove, No. 2, for door.
4 pieces 1″ x 6″—10′ Oregon pine for door frames.
356 square feet canvas for roof.
1 pair 4″ strap hinges for door.
2 end gable irons marked "A."
6 rafter irons marked "B."
16 angles at rafter connection marked "C."
8 angles at corners marked "D."
6 ⅝″ x 11″ bolts; plates to skids.
4 ⅝″ x 9″ bolts; skids to girders.
12 ⅝″ x 7″ bolts for connecting parts.
16 ⅝″ x 3″ bolts for connecting parts.
44 ⅝″ x 5″ bolts for connecting parts.

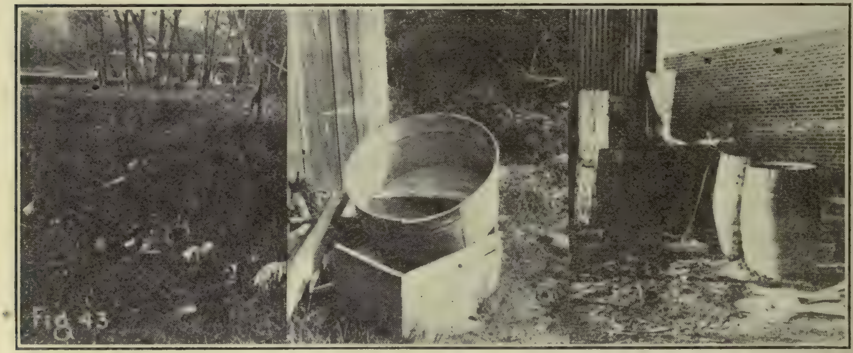
The estimated cost of this temporary composting pit is as follows:

	San Francisco	Sacramento	Fresno	Los Angeles
Material	$45 00	$54 70	$55 65	$46 85
Labor	35 00	40 00	47 00	32 00
Total	$80 00	$94 70	$102 65	$78 85

Figure 40 shows a pile of manure 50 feet long, 45 feet wide and 4 feet high. This manure is near the mess, cook and bunk houses. Millions of flies breed here during the eight months this manure is kept, and hence the bunk, cook and mess houses swarm with flies. It has been found that a pile of horse manure weighing 500 pounds may contain about 300,000 fly maggots at the end of four days' exposure. Besides, from the standpoint of economy alone, this is a poor method of keeping manure, as a large portion of it is wasted by heating and leaching.

On the basis of prices charged for commercial fertilizers, it is estimated that the average value of manure annually produced by each horse or mule is $27; by each head of cattle, $19; by each hog, $12, and by each sheep, $2. Fifty per cent of the value of manure is lost if kept as shown in Figure 40.

Figure 41 shows a pile of manure stacked up against the side of a barn, which is about 50 feet from the kitchen, mess-house and sleeping quarters. This pile of manure is not only a fly-breeding place, but may cause the side of the barn to cave in, or set fire to it.



Tin cans and barrels in which water may stand, affording breeding places for mosquitoes.

XI.

Mosquitoes and Malaria.

Mosquitoes breed in stagnant water collected in pools, irrigation ditches, marshes, barrels and other receptacles left uncovered. Mosquitoes carry malaria from the infected to the non-infected, and a laborer suffering from malaria, or badly bitten by other types of mosquitoes, is only half efficient. Hence it pays to eliminate the mosquito.

1. In regions where mosquitoes are numerous, No. 16 or 18 wire mesh should be used for screening the bunk houses to keep out the mosquitoes.

2. Where tents are used for sleeping quarters in malarial regions, it is recommended that the occupants use mosquito nets over their beds to insure protection.

3. If areas of stagnant water are present about the camp, the sur-

faces should be treated, once every ten days, with a mixture of crude oil and kerosene, half and half, to avoid the breeding of malaria-bearing mosquitoes.

Figure 42 shows a knapsack spray, five-gallon capacity, which is recommended for applying the oil.

Figure 43 shows tin cans and barrels in which water may stand, affording breeding places for mosquitoes.

XII.

Sanitation Service.

1. Each large camp should have one or more able-bodied men, whose entire time should be devoted to the cleaning up of the camp.

2. The cooperation of every person in the camp is needed for securing the best results.

3. It is the duty of every employer to obey conscientiously the law requiring him to report immediately to the local Health Officer all communicable diseases, such as typhoid, smallpox, etc.

4. In camps of 50 or more persons, a fly-proof and mosquito-proof tent house should be provided for receiving the sick.

See page 54 for camp placard.

The Commission of Immigration and Housing of California makes the following suggestions to men in labor camps:

1. Please use the toilets. Do not urinate or defecate on the camp grounds, for this is the direct cause of a great deal of camp sickness.

2. Provide yourselves with urinal cans for night use.

3. The common towel is a carrier of disease. It is better to use your own towel.

4. Be careful to empty all garbage, refuse and slops into the cans provided.

5. Keep your windows or other means of ventilation open to admit plenty of fresh air to your sleeping quarters.

6. Air all bedding and blankets at least once a week.

7. In malaria regions, use mosquito nets over your beds.

8. It is safer to use a drinking cup of your own.

WE HEARTILY AGREE WITH THESE RECOMMENDATIONS, AND TRUST THAT OUR MEN WILL ASSIST US IN KEEPING THIS CAMP CLEAN AND LIVABLE BY FOLLOWING THE ABOVE SUGGESTIONS.

(Owner's Signature)____

The above is a reproduction of a placard which we should be pleased to send you, to be posted at convenient places in your labor camp. Let us know how many you can use, and we shall send them without cost to you.

COMMISSION OF IMMIGRATION AND HOUSING
OF CALIFORNIA,
Underwood Building, 525 Market Street,
San Francisco, California.

0

Snow-drifts in the higher altitudes sometimes block the motorist's way.

MOTORING IN THE HIGH SIERRAS

By Charles J. Belden

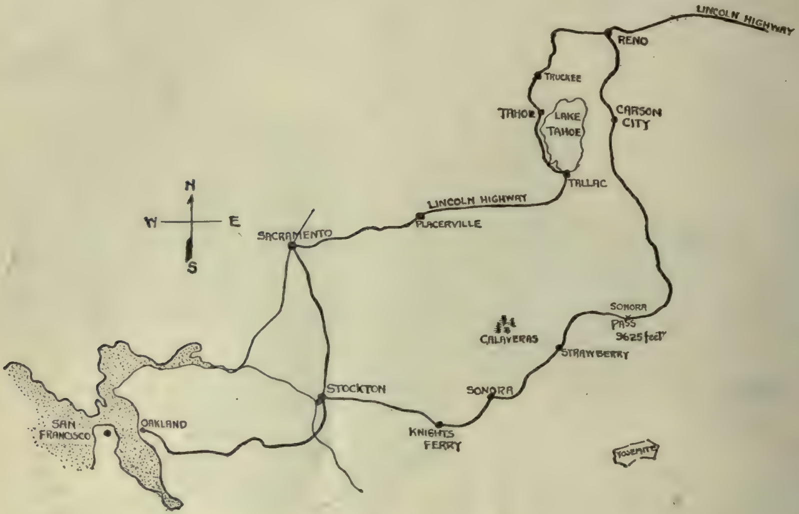
ILLUSTRATIONS FROM PHOTOGRAPHS BY THE AUTHOR

" Out beyond the high Sierras, where the world is big and free,
My thoughts do often wander, and 'tis there I long to be,
For the stately pines do whisper and the rugged peaks they call
When the sun sinks down behind them in a blood-red fiery ball."

TO the motorist with pioneering instinct who delights in exploring the unbeaten paths of the wilds, the great chain of the snow-capped Sierran cordilleras of our western coast offers untold possibilities. The high passes of the Swiss and Italian Alps have long since become familiar touring-grounds, and every season witnesses the passage of thousands of motor-cars over the Simplon, the St. Gothard, the Mont Cenis, and other of the well-known Alpine roads.

The Stelvio Pass of the Austrian Tyrol has always held an undisputed supremacy in Europe as regards altitude and difficulty of ascent, and, notwithstanding the high degree of reliability of present-day machines, many motorists hesitate before crossing this pass. The Stelvio reaches an altitude of 9,041 feet above sea-level, and even in midsummer the traveller may expect to encounter snow-storms on the summit. This altitude, however, is surpassed in America by a comparatively unknown pass in the Sierra Nevada Mountains called Sonora Pass, located about midway between Lake Tahoe and the

Yosemite Valley. The route that crosses the mountains at this point is known as the Mono State Highway and attains an altitude of 9,625 feet above sea-level (U. S. G. S.). In point of grandeur and superb scenery, this region is equal to that of the Stelvio or any other of the more travelled Alpine routes of Europe, and in addition possesses a variety of features which are to be found in no other part of the world. A writer, in describing various localities of the world, most suited for motion-picture production, recently said: "California is, indeed, an adaptable place, scenically speaking. On a moment's notice it can be made to resemble any one of the known countries of the civilized globe and some that aren't known or civilized."

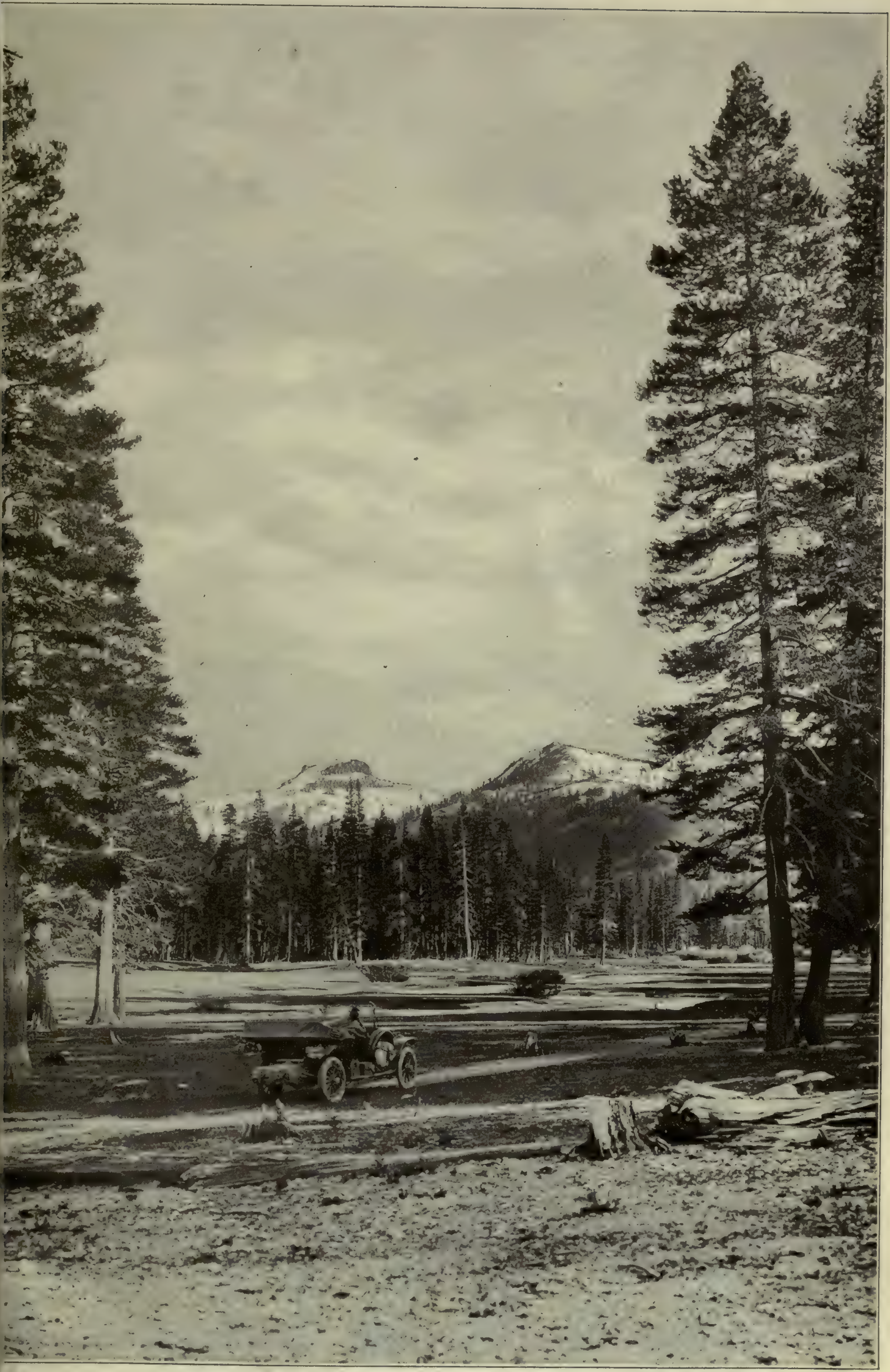


Route over Sonora Pass.

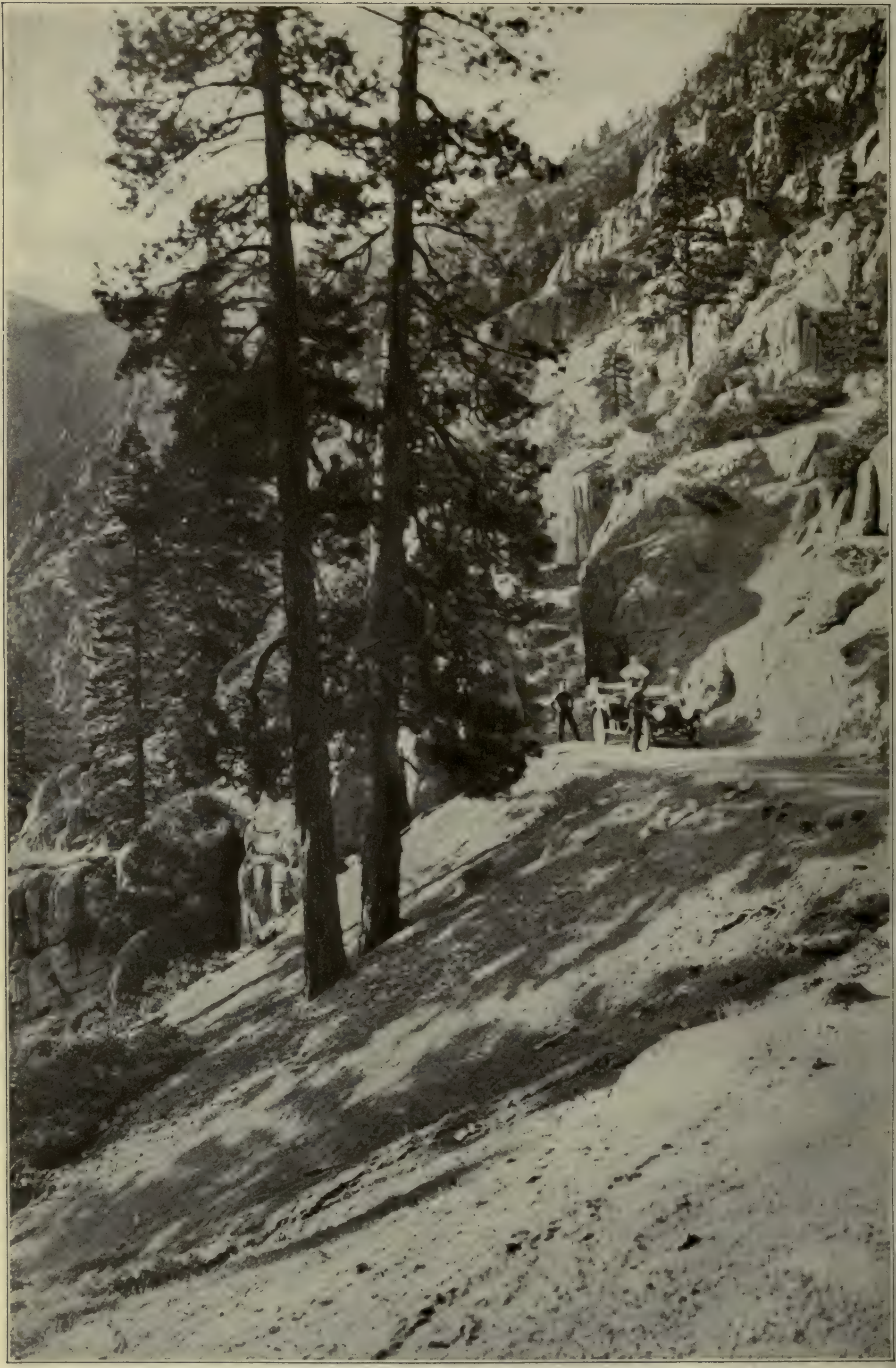
The Sierras combine at once, on the western slope, a vegetation of the mightiest trees of the earth; on the east, a massive wall of granite that rises from a shimmering desert below the level of the sea; and between the two, a magnificent line of snow-capped peaks thrusting their jagged summits far into the eternal blue of the sky. These mountains are distinctively hospitable. In the summer there are no storms to drive the traveller from the summits, no avalanches to be feared, and, except for an occasional afternoon thundershower, the sun shines every day through a crystal atmosphere.

Sonora Pass is approached from San Francisco, on the west, over wide, smoothly oiled boulevards to Stockton, the metropolis of the San Joaquin delta. From here the road leads to the sleepy town of Sonora through the region once inhabited by Bret Harte's picturesque characters. Many of the relics of the gold days are still in evidence, but the booted miner and the sallow-faced gambler have disappeared, and the old-timers who can recall the author of "The Luck of Roaring Camp," "Tennessee's Partner," and other stories of '49 are hard to find. After leaving Sonora the road passes up through the brown foot-hills scantily clothed with oaks, maples, California laurel, and with occasional digger and piñon pines to remind one of the cool forests of magnificent conifers beyond. A short distance to the north of this route lies the Calaveras Grove of Big Trees, one of the noblest of all the groups of *Sequoia gigantea.* Forty miles to the southeast as the crow flies is the wonderful Yosemite Valley; which, to the good fortune of the motorist, is open to automobile travel during the summer months.

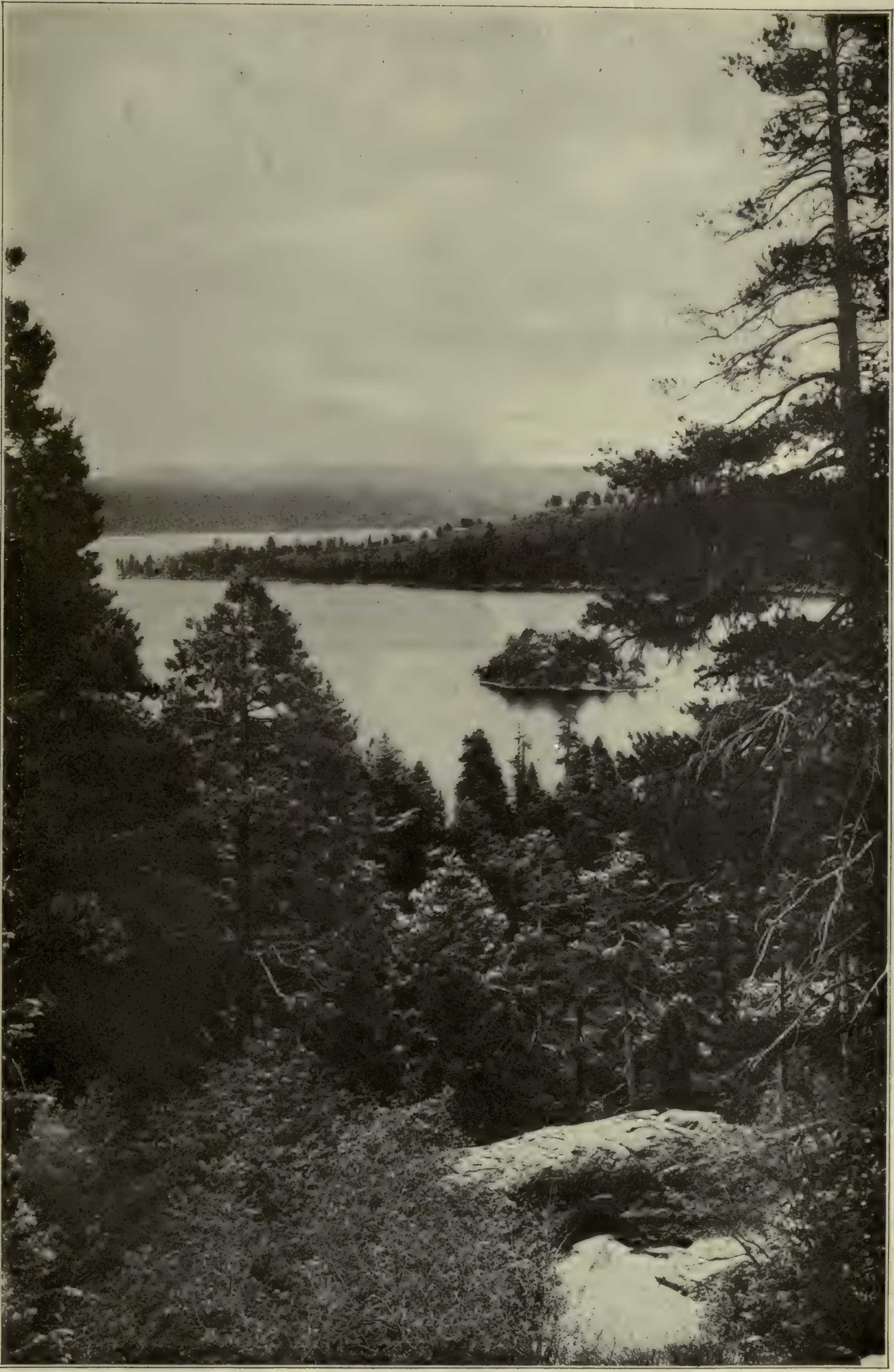
Perhaps the most inspiring feature of the beauty of these mountains is to be found in the granite gorges and canyons that cleave the western slopes to depths of three and four thousand feet. These can-



A Sierra meadow guarded by snow-capped peaks.



The struggle between trees and granite begins at an elevation of 7,000 to 8,000 feet.



An island-studded inlet of Lake Tahoe strongly reminiscent of its Italian sister Lake Maggiore.

A granite bowlful of cobalt-blue water transparent and unrippled.

yons, of which Yosemite is the most beautiful and most widely visited, are thought to be the result of violent earth cataclysms and subsequent erosion by ice and water. Sheer walls of granite thousands of feet high, that have been smoothed and polished by mighty rivers of ice, cannot help but impress one with the tremendous dynamic forces of nature.

Continuing up through the foot-hills, the grass beside the road gradually becomes greener and flowing streams replace dry creek-beds. Tall, stately pines and sequoias begin to appear, and an exuberant vegetation supplants the dry, sparse growth of the lower country. For a distance of five or six miles the road follows along the top of a ridge fifteen hundred feet above the North Fork of the Tuolumne River, finally climbing over the divide and dropping down on the other side to the South Fork of the Stanislaus. This river is crossed at a small mountain settlement named Strawberry, and from this point there is a stiff climb to the top of the next ridge; but the view from the summit looking down two thousand feet into a deep granite gorge, with a tumbling stream at the bottom, well repays the effort of ascent. There is now a restful glide of three or four miles down to the Middle Fork of the Stanislaus, which is crossed at Brightman's Flat and whose banks are closely followed to one of those beautiful mountain garden spots known in this case as Kennedy's Meadows.

This point is six thousand two hundred feet above sea-level and marks the beginning of the last climb to the summit of the pass. The grade rises very steeply and at the end of the first mile the river has been left almost a thousand feet below. The steepest pitch is, by measurement, twenty-seven per cent at a point called the "Q-de-Porka." This place is a narrow defile through the solid rock, a hundred feet in length, forty feet deep, and just wide enough to allow a machine to pass. With an underpowered machine "Q-de-Porka" would present serious difficulties.

The scenery now becomes more rugged; the large trees begin to disappear and are replaced by gnarled and twisted specimens entirely lacking in the symmetry and rich foliage of their lower neighbors. The road leads steadily upward, and as one gazes at the serrated outline of the peaks towering above, it seems as though the road could go no farther and that it must momentarily come to an abrupt end against a granite wall. Just as this is about to happen, however, a narrow canyon opens up on one side and a steep rise half a mile in length brings the summit into view. The motorist is now above perpetual snow-line, and if it is early in the season snow-drifts may block the way. By the first or middle of July, however, the road has usually been opened to ordinary travel by the California State Highway Commission and may be relied upon as being in passable condition. A glorious run on high gear through beautiful alpine meadows, covered with succulent grass and spring wild flowers, brings one to the foot of the last ascent, which is rather abrupt but fortunately only a few hundred feet in length. On all sides rugged granite peaks rise into the impenetrable vault of hollow space above, and the silence and desolation of this inferno of rock and ice are broken only by the hum of the motor. As the last rise is surmounted at good speed on second gear, both hand and foot brakes are suddenly applied and the startled passenger in the tonneau is brought to his feet by the yawning chasm in front. The summit has been gained and the crest is so narrow that the water from the overflow of the grumbling radiator trickles away to the east while the rear wheels are still resting on the western slope. The scene that falls away under the traveller's feet is almost terrifying in its aspect and gives one the familiar sensation experienced in a rapidly descending elevator. The words of that genial and beloved mountaineer Clarence King are recalled and describe the view with the fidelity of the genius he possessed:

"East the whole range fell in sharp, hurrying abruptness to the desert, where, ten thousand feet below, lay a vast expanse of arid plain intersected by low parallel ranges traced from north to south. Upon the one side a thousand sculptures of stone, hard, sharp, shattered by cold into infiniteness of fractures and rift, springing up, mutely severe, into the dark, austere blue of heaven; scarred and marked, except where snow and ice, spiked down by ragged granite bolts, shields with its pale armor these rough mountain shoulders, storm-tinted at summit, and dark where, swooping down from ragged cliff, the rocks plunge over canyon walls into blue, silent gulfs."

Behind stood "the West chain, a great mural ridge watched over by heights . . . defining against the western sky a multitude of peaks and spires. Bold buttresses jut out through fields of ice and reach down stone arms among snow and débris. North and south of us the higher, or eastern, summit stretched on in miles and miles of snow-peaks, the farthest horizon still crowded with their white points.

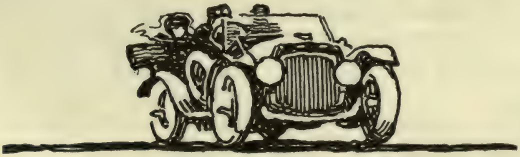
"The two halves of this view, both in sight at once, express the highest, the most acute, aspects of desolation—inanimate forms out of which something living has gone forever. From the desert have been dried up and blown away its seas. Their shores and white, salt-strewn bottoms lie there in the eloquence of death. Sharp, white light glances from all the mountain walls, where in marks and polishings has been written the epitaph of glaciers now melted and vanished into air. Vacant canyons lie open to the sun, bare, treeless, half-shrouded with snow, cumbered with loads of broken débris, still as graves, except when flights of rocks rush down some chasm's throat, startling the mountains with harsh, dry rattle, their fainter echoes from below followed too quickly by dense silence."

A crude mountain bridge spanning the Middle Fork of the Stanislaus.

This country is in striking contrast to that which has been left behind. The fertile valleys and well-watered fields of the western base of the mountains are replaced on the east by a succession of barren, rocky arroyos, alkaline wastes, and dry plains covered with the pungent sagebrush. The descent into this desert country is more abrupt than the long, sweeping slope that has just been ascended, and it is not long before the cool mountain heights are left behind and the odor of hot sage begins to fill one's nostrils. Just before emerging onto the desert there is a delightful, cool meadow known as Leavitt's Meadow which affords an ideal resting-place. The Upper Walker River, which meanders through its soft green turf, dotted here and there with groves of cottonwoods, affords ample sport for the disciples of Izaak Walton. At a point just below the meadow the road forks. The branch to the south leads past Mono Lake, down through the Owens River Valley and Death Valley to join the Santa Fé trail. The branch to the north follows through the canyon of the Walker River and, hugging close under the massive wall of the Sierras, joins the great Lincoln Highway at Reno.

The canyons that cut through the eastern flank of the mountain bear mute evidence of one of the results of the rejection in 1873 of silver as a monetary standard. This region was formerly settled by thriving silver-mining towns, whose relative degree of importance used to be judged by the number of saloons they boasted; but the Demonetization Act of 1873 reduced the value of silver to such an extent that the mines were shut down. There were no other means of livelihood in these rocky Sierra gorges, and the settlements were consequently abandoned to the mercies of winter storms and spring floods. All that remains of Silver Mountain, once a prosperous town of forty saloons and six thousand people, is the stone jail with its iron-barred windows. The forty saloons undoubtedly accounted for the solid construction of this building. To an inquiry as to the present population of a one-time "city" that still lingers in a dejected state, the "oldest inhabitant" replied in a drawl: "Wal, I reckon it's about sixty-five or sixty-seven; I ain't quite sure which."

From Reno the ascent to that wonderful gem of all Sierra lakes, Tahoe, is a matter of a few hours over a well-travelled route. The new State road that leads for twenty-five miles around the western shore offers views over this magnificent body of prussian-blue water that are unrivalled even by the Axenstrasse and Lake Lucerne, or the more subdued beauty of the Italian lakes. The road at times follows the very shore of the lake, enabling the traveller to peer down through the transparent depths. At times sheer rock faces descend to the water's edge and the road circles upward along ledges cut from the solid granite. At one point the road-bed traverses the face of a cliff five hundred feet above Tahoe's surface and presents an outlook over an island-studded inlet strongly reminiscent of its Italian sister Lake Maggiore. Passing under the snow-capped mass of Mount Tallac, a wide and well-graded route leads down beside the rushing torrent of the American River, out, through the foot-hills, to the well-oiled boulevards of the Sacramento Valley.



THE WOMAN AT THE WHEEL

By Herbert Ladd Towle

ILLUSTRATIONS BY S. WERNER, AND FROM PHOTOGRAPHS

WHAT changes a dozen years have wrought in motoring! Men no longer buy cars for the fun of discovering why they won't go, but wholly in the prosaic expectation that they will. Little do the beginners of to-day know of the stern joys of conquest which once made every mile a triumph! To-day a man must drive his car to death to have anything more serious than arrest happen to him. And now we see women driving motor-cars for all the world as if they belonged at the wheel!

Young girls, most of them, hardly out of their teens—they meet you everywhere, garbed in duster and gauntlets, manipulating gears and brakes with the assurance of veterans. Not always in little lady-like cars, either. If you visited last summer a resort blessed with good roads, whether East or West, you saw "sixes" of patrician fame and railroad speed, with Big Sister sitting coolly at the wheel, pausing at the post-office on their way for a country spin. And you wondered if the callow youth seated beside the competent pilot would ever have the gumption to handle a real car himself!

An amazing change, even from the view-point of only three years ago! Have the women suddenly gained courage, or have motor-cars altogether lost their formidable mien?

Something of both, no doubt, but especially something of the latter. Cars are being perfected, not merely in delicacy of control, but in the total elimination of certain demands for strength and skill. Engine-starters—now next to universal, save on the lightest cars—are the most notable instance. You no longer whirl a crank or dexterously "snap her over"; you merely press a foot-plunger and an electric (or sometimes pneumatic) motor spins the engine merrily till the explosions start. A storage-battery furnishes current for both starter and lamps and a little dynamo mounted on the engine keeps the battery charged. It isn't a toy, that starting-motor; some kinds are powerful enough to propel the whole car while briskly turning the engine!

Cranking-up is not the only task that the woman driver may now avoid. Gear-shifting, in the larger cars, demands real strength as well as knack. Some progress has been made of late in developing electric gear-shifts, operated by buttons on the wheel. You press the proper button at leisure; then at the right moment you unclutch for the briefest instant—and the gears shift automatically.

A control feature that requires no strength but lots of "knowing how" is the spark advance. Many persons who handle the wheel well, but have only a vague idea of what is under the hood, never acquire that difficult art. A "spark knock" means nothing to them; they are deaf alike to the piteous pleadings of their cylinders and to the rumblings that tell of late ignition and a heated engine. For these chronic amateurs the automatic spark advance, to be found on a number of cars this year, is an unalloyed boon; and even to the seasoned driver it is a benefit, as meaning one less control to think about.

The tire problem, it must be admitted, remains in an unsatisfactory state. Power-pumps there are, but simply getting the tire on and off is no light task. With practice a woman can manage a small tire, say up to 32 × 3½ inches. Some can handle larger ones; but, as a rule, if even a medium-sized tire goes flat a woman must have masculine help, and

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